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ELECTRIC LIGHTING FROM CENTRAL STATIONS.

FOR one hundred and thirty-four years past the Society for the Encouragement of Arts, Manufactures and Commerce has successfully upheld its unique position among British institutions in popularising the arts and sciences as rapidly as they became developed, and the Society continues to follow up all questions of industrial progress to the point of their practical accomplishment. No sooner had the introduction of electric lighting dawned upon the public mind than the subject was taken up by the Society of Arts, and, as early as 1881, Professor W. Grylls Adams delivered a course of four lectures explaining the scientific principles involved in the production of this comparatively new illuminant.

Considering the exceptional opportunities of this Institution with its 3,500 permanent members, its hundred associated societies spread throughout the country, and its well conducted and widely-read *Journal*, we are not surprised that earnest men flock to it with the intention of receiving or imparting knowledge of a useful kind.

Many of our readers will remember the brilliant gathering on the occasion of the opening of Session 1882, when the late Charles William Siemens (afterwards Sir William) delivered his Presidential Address. Never had a presidential address been listened to with greater interest, and almost the entire discourse was a revelation to all but a few of that crowded assembly.

Siemens dealt with *central station lighting* and the technical questions involved, which, he said, *were not yet sufficiently well understood to admit of immediate operations upon a large scale.* Attention has thus been called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the difference of potentials which should be allowed in the conductors. In his evidence before a Select Committee of the House of Commons in 1879, Siemens limited the desirable area of an electrically lighted district in densely populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo machines and conductors at £100,000, and in the address above referred to he gave a specific example, by way of illustration selecting the parish of St. James's with a population of about 30,000, and containing in round numbers 3,000 inhabited houses distributed over an area of 784,000 square yards, or slightly above a quarter of a square mile. It was assumed that only about one-fourth of the total lighting required would suffice for the estimate then under consideration; and this necessitated 63,378 incandescent lamps, demanding an expenditure of 7,042 horse-power of energy. Siemens estimated the cost of engines and dynamos at £140,000, and the cost of establishing the conductors at £37,000, bringing the total sum for central station and leads to £177,000. The cables were supposed to be placed underground. Alternating current transformers were not even hinted at, but it was suggested that high potential continuous currents "could be passed through a secondary dynamo machine to give motion to another primary machine, producing currents of low potential to be distributed for general consumption; or secondary batteries might be used to effect the conversion of currents of high potential into those of low potential, whichever means might be found the cheaper in first cost, in maintenance, and most economical of energy." Referring to the working charges with 64,000 lights, the consumption of coal in St. James's would amount to £18,300 in money value; wages, repairs, and sundries, £6,000; depreciation at 7½ per cent., £13,300; general management, £3,400—making a total of about £41,000, or at the rate of 12s. 9½d. per lamp per annum. Adding to this the cost of renewal of lamps, which were taken at 5s. each of 16 candle-power, lasting 1,200 hours, the total cost per lamp for a year amounted to 21s. 9½d. Siemens endeavoured to show "that electric light by incandescence, when carried out on a large scale, is decidedly cheaper than gas lighting at present prices, and with the ordinary gas burners." These statements were, of course, hypothetical. Nearly six years have elapsed since that memorable night, and we have not much advanced in the matter of central station lighting.

Mr. Crompton resuscitated the ideas of Siemens in a modified form last week, in the same room, and before a smaller and less appreciative audience. Mr. Crompton did his best, no doubt, and the Society of Arts is as representative and as flourishing a body as ever; but the public interest in electric lighting has, we fear, waned considerably, or perhaps we should be more correct in saying that there is now less enthusiasm apparent, although we trust that the public view of the matter is of a more substantial and durable nature than was the case a few years since. "If," said Mr. Crompton at the end of his paper, "I have succeeded in bringing home to you what a powerful factor in the success of electric lighting is the intelligent co-operation of the public themselves who want the light, I shall feel that I have succeeded in my object." And the object of the paper was "to put before the Society of Arts some data from which you can form your own opinions on the vexed question whether the electric light will soon be generally distributed as a means of lighting our houses." Then he proceeds as follows: "As I believe, after all, that the cost of electric lighting will be the chief factor in determining its future extension, I think it best to commence by showing you that the main body of householders can only afford to spend a certain sum on their lighting; so that, if the electric light cannot be supplied for this sum, its use will be restricted. . . .

A Londoner who is tenant or owner of a house having three reception rooms, ten bed rooms, and the usual offices and passages—in all, having about 50 burners fixed in them—spends about £25 a year for his lighting. His gas bill will be about £15 ; lamps, oil, candles, and matches, about £10. His average coal bill will be about £25. But this £50 does not nearly represent the total cost of his lighting and heating. Repairs, renewals, cleaning of the house and furniture inseparably connected with lighting and heating, form a large item—in fact, a larger item than anybody would imagine who had not added them up and averaged them over a term of years. Although a great deal has been made of the damage done to ceilings, hangings, the bindings of books—in fact, everything fixed in the upper part of our rooms—by the fumes and smoke of burning gas, few people consider what a large share of the labour of our household servants is connected with cleaning grates, carrying coals, and the dusting of furniture caused by the use of coal. . . . And it is quite certain that if the electric light was introduced into such houses, and the bulk of heating and cooking done by gas, then this heavy annual bill would be considerably reduced, probably by £30 or £40 at least. Our householder could then well afford to pay £25 for his electric light, £20 for the increased quantity of gas he would use for heating, and as English people will always insist upon an open grate in the drawing room, £5 for wood fuel for his drawing room fire. His pocket would then be the gainer of the £30 or £40 that he would save in repairs."

Mr. Crompton considers that the supply companies cannot charge much less than 8d. per Board of Trade unit for electricity, and that the £25 a year means a trifle over two units a day, and that this is sufficient for 62 lamp-hours, with 10-candle lamps of 33 watts each, "experience having shown at Kensington that this is the nicest lamp to use." In his table of working expenses and maintenance of a 10,000-light plant (600 kilowatts), the actual cost is 3·75 pence per unit with the A.T. system, and 2·7 pence per unit for the B.T. system, including all possible and apparently liberal charges. According to this there ought to be a very good profit made on central station lighting. "The tables, which are based on the supposition that two houses out of every three fronting the mains will take the light, show that capital invested in plant ought to earn a dividend of at least 10 or 12 per cent., after putting aside a sufficient reserve fund to meet depreciation, and all such charges." These tables, it may be mentioned, are the same as those given by Mr. Crompton in his paper before the Society of Telegraph-Engineers and Electricians, and published in the ELECTRICAL REVIEW of April 20th, and the figures contained therein are necessarily also hypothetical like those of Siemens. Such figures are of little interest to the public, and capitalists will want to know first of all whether there is the demand for the electric light. Now this demand must be created by the facilities of obtaining the supply. We believe that if central stations were erected in suitable quarters there would be no lack of customers, provided that the supply is absolutely regular, for few people who value their health and comfort will grumble at the higher price of the electric light. Reference was made during the discussion on Mr. Crompton's paper to the electric lighting industry in the United States, but we believe that nearly every one of the statements offered requires correction or modification.

Surgeon-Major Ince, for instance, said that coming from America to England he felt like coming from light into darkness, and that there was no town of 1,000 inhabitants in the States which had not the electric light. If that gentleman has travelled any distance he must have seen some towns which had no electric lights at all, and some good-sized cities which can only boast of a few dozen arc lamps ; he must also have noticed that the gas lighting in many streets of American cities is very poor, and if the Surgeon-Major has ever walked from Chestnut Street to Walnut Street next to it, in Philadelphia, he must have noticed the extremes of light and darkness between two of the principal thoroughfares of a very large city. The contrast between electrically-illuminated streets and those lit by gas in the States is, as a rule, so great, that the inhabitants naturally prefer to have gas lighting abolished altogether.

Mr. Mordey stated that there is not one central station in America which relied upon accumulators ; he has evidently not heard of that one at Williamsport, Pa., which has been in operation for over a year, nor of several others that are in course of construction.

Mr. Swinburne remarked that America was much behind us in gas manufacture, and that the average price was about 10s. per 1,000 feet as against 2s. 9d. or 3s. in England. The Americans were a nation still developing, and were always ready to take up anything they considered useful ; but a country like England, which had developed apparently as far as it was going, was more like continental countries. Mr. Swinburne does not seem to know that gas, in many of the large cities, where electric lighting was first and most successfully introduced, does not cost above 5s. to 7s. per 1,000 cubic feet. As regards continental countries, he will find an immense application of electric lighting in Germany and Switzerland, two of the most parsimonious nations on the face of the globe.

If Mr. Crompton thinks that all the electric light wires in America are carried overhead, he has omitted to inform himself of the fact that laws have been passed in several States making the laying of cables underground compulsory, and that in many large towns the new rules have been complied with some time ago.

English electricians are continually drawing comparisons between America and England in discussions on electric lighting. The fact that nearly a thousand central stations exist in the United States, and that the number is increasing at an enormous rate, does in no way remove the main causes of the slow progress in England. Legislation may be the chief retarding cause, next comes vested interests, then a good deal of conservatism, and lastly, perhaps, the low price of gas. We have conversed with several managers of electric lighting companies in America on the question of

prices charged to the consumers. The majority of companies do not profess to supply electric light at a cheaper rate than gas; the old customers are satisfied with the higher price, and intending customers seldom if ever expect to profit in the matter of cost, light for light, and in some cases electricity is charged for at a rate twice as high as gas. The American prefers the electric light: it suits his taste, his health, and his convenience, and therefore he patronises it. We believe Englishmen will do the same when they get the chance of finding out the superior qualities of the new illuminant. Mr. Crompton's object was to obtain the opinion of his audience "on the vexed question whether the electric light will soon be generally distributed as a means of lighting our houses." Neither he nor any of the other speakers made an attempt to answer this question, nor did they even allude to it, and in his paper the lecturer referred to difficulties without, however, indicating a rational remedy. There appeared to be two things uppermost in Mr. Crompton's mind when writing his paper, bad legislation and capital; when the one is removed then the other may come forward with its aid; until then calculations and tables will be of little value.

THE other day we had a note on the subject of the difficulty of working high tension underground cables; or rather we referred to an unfortunate remark of a speaker in the Society of Telegraph Engineers controversy to the effect that the experience of the Brush Corporation was discouraging. Perhaps with the desire of preventing an impression getting abroad that the Corporation could not insure anything like certainty in its underground circuits, Mr. Mordey made a few remarks at the Society of Arts on Wednesday last, which are reported in the Society's *Journal*, from which we see that the Corporation's experience with the old City cable was rather encouraging than the reverse. The cable worked for years when one would have thought it impossible to use it at all. It was put down by a contractor in a manner, it is said, which would not have passed muster for ordinary telegraphy. Doubtless, at the present time, underground conductors would be dealt with in a very different way, and even temporary troubles would now be avoided. We refer to this matter in the hope that it may be the means of removing an unmerited reproach.

WE have noted with regret that for some time the tone of the proceedings at the meetings of the Society of Telegraph Engineers has not been characterised by as much dignity and decorum as the standing and aims of the Society demand. It is, no doubt, very difficult to avoid a certain amount of levity when unimportant questions of a more or less personal character are permitted to be treated as of general interest to the profession; and this difficulty is not lessened by the introduction, on the part of prominent speakers, of slang terms and jokes of a character that lack refinement. On more than one occasion lately the members have been treated to exhibitions of this kind, and to unblushing and undisguised touting and puffing of the wares of makers or dealers. Such things should not be tolerated. The Society is the foremost electrical body in the world, and its proceedings are critically regarded wherever an interest is felt in electrical questions. It is therefore incumbent on it to cultivate a tone which will at any rate bear comparison with other societies. The Society necessarily has to deal, occasionally, with questions of a commercial character, but in doing so it should be remembered that its primary object is to obtain and to disseminate accurate *data* on the scientific and engineering aspects of these questions.

IN the issues of *Engineering* for May 11th and 18th we notice a detailed account of the boiler explosions which occurred in 1887. It would appear that the greatest number of accidents took place in boilers employed in ships (10), on farms (8), and for heating or drying (10), the explosions being chiefly due to corrosion, external and internal, and to over pressure, both being causes which should have been detected, in the first case, by proper inspection; in the second, by the attendants. The average annual loss of life per year from 1862 to 1882 was 68. Since 1882 the average has been only 30, so it seems that the evil is decreasing. As electric lighting has but comparatively recently come into anything approaching an extended application, sufficient time has scarcely yet elapsed for this industry to take a place in the record of carelessness and indifference published by our contemporary.

GLASGOW is a city of philosophers and sages. It is none the less famous in that it is the dwelling place of Sir William Thomson, a sage of sages. But the city contains an even greater genius than Sir William. The great scientist has usually facts to go upon, and his most famous treatises are but transcriptions from Nature. The genius who has revealed himself to us within the past week, or rather who has been revealed to us by no less than four kind correspondents, is the newspaper man who writes "Gossip at the Groveries" in the *Glasgow Evening News*. He has not had the advantage of long training in the study of Nature's ways, as has his learned neighbour of the University; but his wonderful intuitive knowledge, his acute inner consciousness, has enabled him to comprehend what no other man has been clever or inspired enough to discover. Here is the grand discovery of the age relative to the character and conduct of lightning:—

> I heard several timorous people ask the question last night—"What effect has lightning on the electric light?" Let me allay their fears. There is no danger whatever. The current from the time it leaves the motor is protected by strongly insulated wires, and lightning therefore cannot touch it there. Should the natural electric fluid find its way to the dynamos it might cause the light to flare up momentarily, but that is all. The current which drives the lights is quite strong enough to absorb the lightning. Telegraphs and telephones are easily affected, because the current is a weak one, and passes along strongly-tensioned and uninsulated wires.

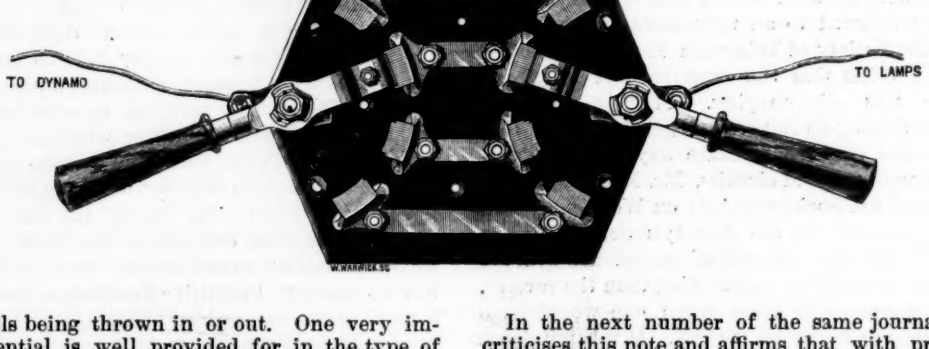
OUR correspondent who desires to preserve his "incognito," to which preservation there is no objection as he only takes us to task, has weighed the advantages and disadvantages of anonymous correspondence very fairly and well. Indeed, so eloquently does he state his case that we felt almost inclined to rescind our decision of last week, but we feel that the great majority of those who desire to make use of our correspondence columns have really no objection whatever to attaching their own names to their communications.

ACCUMULATOR REGULATION.

THIS is a subject to which recent discussion has given an increased amount of prominence, and as the general efficiency of accumulators depends so much upon the observance of rules which a concensus of experience shows to be necessary, any aid to making these easy is of importance.

We illustrate a very simple and compact form of combined charge and discharge regulator, made by the United Electrical Engineering Company, Limited, who are manufacturers of Drake and Gorham's patent ring contact switches. The purpose of this switch is to enable lamps to be run while cells are being charged, the volts on the lamps being kept practically constant. While charging the battery the pressure at its terminals is necessarily at a number of volts above that at which the lamps are gauged to work, but by moving down the right-hand handle the lamps can be connected to just so many cells as will give them their proper pressure. In installations where the engine is run during the heaviest part of the lighting, the batteries being used as regulators, it is essential to be able to charge the "extra" cells ready for use after the engine stops, which can be done by moving the charging side of the regulator until it is connected with the whole battery, the lamp connections being varied until the required E.M.F. is obtained.

Our illustration shows a four-way switch for a 50 volts circuit; it is usual to employ a six-way for those of 100 volts. Where variations of pressure are very great each contact may be connected so that it represents two



or more cells being thrown in or out. One very important essential is well provided for in the type of switch which we illustrate—the movement of the lever from one contact to the other is so quick that the current is not perceptibly interrupted, but nevertheless no short circuit of the cells takes place. The switch is strongly and reliably made and has an incombustible base.

Gas Companies and Electric Light.—An official of the Westinghouse Electric Company recently said:—"We are now selling more motors and electric apparatus to gas companies than to any other concerns. Only yesterday the gas company of Columbus ordered an apparatus from us. It realises that electric light is so fast gaining in public favour that it might as well have the privilege of supplying its customers, or anybody else, and as we give the agency of a certain district only to one party, gas companies are anxious to secure them. Yes; gas illumination has seen its longest day, the numerous improvements that are almost daily made in our methods of using electric light are rapidly getting toward perfection, and as electricity advances gas retreats." In the same connection we read that the New Bedford Gas Company has purchased of the Thomson-Houston Company a complete motor plant consisting of a 50 horse-power generator and various sizes of motors, aggregating 36 horse-power.

GALVANOMETER SUSPENSIONS.

SOME time ago there were in my possession, writes G. A. Liebig, jun., of Johns Hopkins University, in the *Electrical World*, several varieties of silk fibres, on which it seemed worth while to experiment, with a view of determining what treatment was best suited to fit them for galvanometer use. That treatment of some sort is necessary is perhaps evident to everyone who has had occasion to use galvanometers with very delicate suspensions. The effects or defects which have been particularly noticed in silk fibres are changes in the torsional rigidity of the fibre and occasional sudden rupture of the thread without apparent reason, the latter causing often the same mishap to befall an expensive mirror.

In the *Phil. Mag.* of December, 1886, shortly after my experiments were begun, R. M. H. Bosanquet in a note on "Silk *v.* Wire for Galvanometer Suspensions" calls attention to the trouble he experienced from capricious movements of the needle due to some structural changes in the silk suspension. He remarked that during certain hours of the day—generally in the early morning or late in the afternoon—the needle without any warning would begin a series of movements about the zero point, and so irregular were the vibrations, and of such amplitude, that satisfactory work with the instrument when these once began was out of the question. After various attempts to correct these faults without success, Mr. Bosanquet decided to return to the old wire suspensions, and constructed a special instrument to that end. With this arrangement he stated that very good results were obtained.

In the next number of the same journal Mr. Gray criticises this note and affirms that with proper treatment of the silk fibres, and, above all, the exercise of precaution in separating the threads, no errors are introduced—at any rate for all ordinary work—by the use of silk. Mr. Gray has determined the torsional rigidity of silk threads, and shows that there is no reason why silk should be abandoned even for the most sensitive astatic galvanometers. For instruments of great sensibility the rigidity of the fibre may become an important quantity, but by strengthening the magnetic field in which the needles move and increasing the length of the suspension, the error due to this cause may be reduced to a minimum. For astatic galvanometers there is no danger of considerable errors as long as the difference in the magnetic fields in which the needles are suspended is more than $\frac{1}{10}$th the mean horizontal intensity of the earth's magnetic force.

As far as structural changes go, the condition of things would scarcely seem to be improved by the employment of metal for suspending magnets. The wire is certainly more easily influenced by a permanent set, especially if long deflected from zero, than a silk thread would be, and it would be very difficult to allow for.

In the case of silk thread these "structural changes" can be cured or rendered negligible at any rate, and the process thus involved seems to have the effect of increasing the tensile strength of the material.

I think the sudden rupture of the thread and unreasonable oscillations about a changing zero can be explained in this way. The ordinary cocoon fibre consists of an inner mass or core similar in structure to hair or horn, insoluble in water, alcohol and dilute acids; and an outer layer of gummy substance of a gelatinous nature, which dissolves readily in hot water or dilute alkalies. The latter constitutes about one-third the mass of the fibre. Now if the fibre is exposed alternately to damp air and dry air it seems reasonable to suppose that the external covering, changing from a soft to a hard, brittle mass, gradually weakens the inner core until it can no longer support the suspended magnet and attachments and breaks. It seemed probable, therefore, that if by any means the gelatinous covering of the fibre could be removed without injury to the inner structure, the fibre would be greatly improved.

The silk examined was of four kinds, namely, Chinese cocoons, a mass of fibres arranged in a circular disc, American cocoons, and a variety of silk known as "tussus"; this was already reeled.

The second variety was peculiar. The silk was arranged matted together in the form of a circular disc about 4 inches in diameter, and perhaps a twentieth or thirtieth of an inch thick. The mat was of a yellowish colour, and the fibres were rather closely packed, yet not so closely as to prevent long threads from being drawn from the mass. I have not been able to find a description of this kind of silk, but am informed by the gentleman who gave me the mat that the "silk worms are trained to spin their product in such a form," a statement which would indicate a possible educational development of the silkworm to such an extent as to render dressmakers a useless species.

The variety known as tussus is not at all uncommon, this being in reality only another name for pongee silk. The tussus threads are exceptionally tough and strong, and very much thicker than ordinary cocoon fibre. A single thread of pongee silk can easily support a weight of from five to seven grammes, whereas ordinary silk threads reach their limit at about two grammes.

The examination of the silk was conducted in the following way:—After drawing fibres of the desired length from the cocoon, they were split up into their two parts. Cocoon threads are always double, and as the two halves are occasionally well glued together, it becomes necessary sometimes to dip the fibre in hot water in order to effect the separation. To the threads were then fastened pieces of copper wire to act as weights, which, having a very small moment of inertia, allowed the threads to untwist themselves without difficulty. The threads were then hung up inside glass tubes and steamed from fifteen to twenty minutes, after which they were dried and fastened to hooks inside a large rectangular box with glass sides.

Side by side with the steamed fibres were hung up a number of threads which had not been steamed. Small pointers were attached to the weights, and beneath these were a series of circular scales by which the extent of untwisting or twisting of the threads could be measured. The positions of the pointers having been observed, the air in the box was alternately dried and rendered moist by pumping into the box air which had previously been passed over calcium chloride or water. This was done very carefully and slowly, so as to avoid setting the fibres in vibration. Some of the motion which resulted may have been due to the mechanical movement of the air; but to eliminate as far as possible errors from such causes the fibres were moved from place to place in the box, so as to be equally exposed to the action of the air currents; but the effects were nearly always of one kind.

In a few minutes after making the air damp the fibres began to vibrate or untwist. After a few revolutions in one direction a rotation in the opposite direction ensued, and many of the unsteamed fibres broke. Very few of the treated threads gave way, but a large proportion of the unsteamed fibres suddenly parted. It was also noticed that, although both kinds of fibres turned, at first, perhaps several complete revolutions, when the air was changed from dry to damp, the excursions of the treated threads became gradually less as the process was repeated, and finally became negligible, while the others scarcely diminished their vibrations. When the box was exposed to sunlight directly, the untreated threads would begin to vibrate and frequently make several complete revolutions in one direction, whereas the treated fibre seemed to be unaffected.

On steaming the silk it was observed that the threads lengthened themselves considerably, the change amounting to 10 or 15 per cent. of the length. The steaming had very frequently the effect of rupturing the threads, which always untwisted themselves as soon as they became wetted.

Instead of steaming them, a number of the fibres were immersed in a very dilute solution of caustic alkali, one part in 40 or 50, and afterwards in dilute acetic acid to neutralise the alkali clinging to the thread, and also to exert a solvent action, for about the same length of time, in general a few hours. They were then washed in pure water. It was thought that the acid and hydrate would more effectively dissolve the outer coating of the silk thread and thus still further improve them. However, the method seemed scarcely an improvement, all things considered, over steaming or careful and thorough washing in hot water, and, after all, the latter accomplishes about everything that could be desired.

Although the outer covering and gummy substances surrounding the fibre proper are probably responsible in a great measure for whatever trouble silk suspensions may cause, there is no doubt that in many cases the irregularities can be traced to the failure of separating the threads, so that, in reality, the magnet is supported by a double instead of a single fibre.

ON "FLASHING" CARBON FILAMENTS AT DIFFERENT TEMPERATURES.

By LEGH S. POWELL.

(*Concluded from page* 533.)

Fall in Resistance.—One of the principal reasons for conducting the second series of experiments was to ascertain whether the resistance in the finished lamps falls more with slow than with brighter flashing. The answer given by Series I. is doubtful, because of the different amounts of reducing the filaments received. The evidence in Series II., however, not only settles this point by stating definitely that low-temperature flashed filaments do really change the most, but it does so in a very forcible manner; for, as already explained elsewhere, the slowly flashed filaments received a smaller amount of reducing than their due in consequence of the fixed fall of 20 ohms, common to both experiments, bearing a smaller proportion to a resistance of 165 ohms than to one of 145 ohms, which are the average figures in the two experiments. Had the resistances been alike, Experiment II. would have naturally shown a still greater drop than 9·5 ohms, while 5·7 ohms for Experiment I. would remain the same. We may, perhaps, assume correctly that this variation in temperature is the principal cause for the alteration in the resistance in finished lamps—at any rate, when the flashing has been between comparatively low temperatures; but we must not lose sight of the fact that it cannot be the sole cause, for although we have (or should have with equal resistances) a difference of about 50 per cent. between the experiments in this respect we have an equal amount of variation in the individual experiments themselves, and difference in temperature was certainly not the cause in the latter cases. There is, moreover, no trace of connection to be followed between the falls in resistance and the times, weights, or resistances of the filaments, so that either none exists or else it is entirely obliterated by other influences

which are at work either promoting or checking the changes. We have certainly result 11 slightly, but consistantly indicated, viz., that there is a smaller range of alteration in the more slowly flashed filaments than in those more brightly conducted, but although we may be sure that the fact is very significant, it is difficult to see how it helps us. Result 9 is similar to this, and shows us that slow flashing is more conducive to securing an even set of filaments than brighter flashing. But this is no doubt to be explained solely, or at any rate mainly, on the ground that there is less liability to manipulative error in adjustment when flashing at low temperatures. This reason, however, does not solve the problem of the decreased range in the fall of resistance. It is just possible that the discrepant figures in the individual experiments may be due in some measure to the method employed of causing the lamps to fall being faulty. It may be that different lamps require very different times to enable them to fall, and there are not wanting grounds for this supposition, and accordingly only average results can be depended upon. But this idea is little more than conjecture, and we must remain satisfied for the present with our one clearly proved fact of the influence of temperature over the fall in resistance.

We see, therefore, that slowly flashed filaments have apparently the most tendency to rise in resistance after flashing in the cold, and they have also most tendency to fall again in the finished lamp, but as a whole they do not return to the same point at which they started for the "final" readings of the lamps of Experiment II.; Series II. are still considerably higher than even the "initial" ones of Experiment I.

Apart from this investigation one or two interesting facts on this subject may be mentioned before we close which will serve to give a fuller though hardly more lucid view of this phenomenon of variation in resistance in general.

It is well known that the pressure on the gaseous medium in which the filament is flashed exerts a powerful and mysterious influence in this matter of the subsequent liability of deposited carbon to alter its resistance. Even when filaments are flashed in coal gas at the ordinary atmospheric pressure, and then reduced in a partial vacuum containing some suitable carbon compound, they become practically unalterable. The temperature required to deposit carbon on a filament in vacuo must of necessity be very high, and it might be supposed that this high temperature is the main cause for the increased steadiness. But this notion is disproved by an experiment which was made of flashing filaments in coal gas in the ordinary manner, and then reducing them in the vapour of methyl alcohol, which enables the filament to attain a very high degree of incandescence in consequence of its slow rate of decomposition, and yet no noticeable diminution was observed in the fall in resistance experienced by the lamps thus made, over those reduced in amyl acetate vapour.

By heavily flashing thin filaments at a very low temperature in the vapour of amyl acetate at the ordinary pressure, it is possible to produce lamps which fall in resistance to an enormous extent, so much so that if such a lamp fresh from the pumps is left running on a circuit at about 3 watts per C.P. it will gradually brighten until it breaks in a few hours. A lamp made under these conditions gave the following "initial" and "final readings":—

	V.	A.	C.P.	W.	Calculated R
Initial reading ...	33	1·102	10	3·6	= 29·9 ohms.
Final reading ...	33	1·45	23	2·08	= 22·7 „

At the commencement of this paper reference was made to the fact that lamps would sometimes alter in resistance even when stowed away in boxes. The experiment has been made of selecting a number of freshly made lamps so as to run perfectly evenly together on a rack and then boxing them up for a week or so. On re-running them some have been found to have become a little brighter and others a little duller than at the commencement. If, now, these lamps which have altered be each run at about 2·7 watts per C.P. it is usual to find that the brighter ones will fall considerably further still. The duller ones will also fall when similarly treated, but to a smaller extent.

It by no means follows that after a lamp has been run brightly as described in the earlier part of this paper, for the purpose of enabling it to fall in resistance if it has a tendency that way, that it will remain absolutely steady at this point during a period of rest. It will on the contrary sometimes rise again in resistance perceptibly and quite enough to cause trouble and annoyance to some of those persons familiar with the selection of incandescent lamp standards, although fortunately for those persons this phenomenon is a somewhat rare occurrence.

From the experiments above described, and from the remarks which have been made in connection with them, the scientific mind will be able to perceive what a vast and interesting field exists for further enquiry in this one little matter of the liability of carbon filaments to change their resistance when they are manufactured and treated under different conditions. It may be moreover added that one very important and closely allied branch of the subject has not even been referred to, and that is the relation between resistance hot and cold. It is highly probable that close observation in reference to this point would clear up many difficulties which now present themselves, and further light yet would no doubt be obtained by calculating the resistances at different degrees of incandescence both before and after the "initial" and "final" readings of lamps made under different conditions and circumstances. However, interesting as is this subject of resistance, our experiments have opened up to us various other more or less important subjects, such as the effect of temperature of flashing on surface,* weight, size, time, &c., and the connections and laws between these properties. The light, it is true, is a mere glimmer, but it is enough to be both interesting and important, for let us descend from scientific reflection to the practical art of lamp manufacture and see if we cannot make use of some of this knowledge.

We obtain the information that providing equal sized filaments is not enough to secure the lamps being of equal incandescence, but that the surface is liable to change in the flashing process, and that to cure this surface difficulty the flashing processes must be altered. We obtain the information that flashing to a given resistance at different temperatures also tends to make uneven lamps in consequence of changes in resistance which occur, and we learn thereby the importance of securing a fixed and equal temperature during flashing. We see the influence which temperature of flashing has on the extremely important matter of lamps falling in resistance. We see the advisability of high temperature for obtaining this purpose; the desirability of low temperature for securing that one, &c.; we see, finally, the immense importance of further, fuller, and more complete investigation, not only with a view to turning out lamps of equal incandescence, but of the duration of the resulting carbon and of the all round economy.

Electric Light v. Gas.—General Festing, in his annual report to the Science and Art Department of the Privy Council, states that the working expenses in connection with the lighting by electricity of South Kensington Museum amounted to £1,224. If the same portions had been lighted by gas the cost would have been £2,845. There was thus a saving of £1,621, which is 17 per cent. on the cost of machinery and apparatus.

* When discussing the subject of "surface," the fact that the mean resistances of the respective sets of lamps was not the same, was not taken into consideration. It is not unlikely that had the two resistances in Series II. been equal that the slowly flashed filaments would have shown a noticable increase in the surface. But perhaps for the purpose of illustrating the facts commented upon, it is as well that they happened to be different.

MAGNETIC QUALITIES OF NICKEL.

By J. A. EWING, F.R.S., Professor of Engineering, University College, Dundee, and G. C. COWAN.*

THE experiments described in the paper were made with the view of extending to nickel the same lines of enquiry as had been pursued by one of the authors in regard to iron, (Phil. Trans., 1885, p. 523). Cyclic processes of magnetisation were studied, in which a magnetising force of about 100 c.g.s. units was applied, removed, reversed, again removed, and re-applied, for the purpose of determining the form of the magnetisation curve, the magnetic susceptibility, the ratio of residual to induced magnetism, and the energy dissipated in consequence of hysteresis in the relation of magnetic induction to magnetising force. Curves are given to show the character of such cycles for nickel wire in three conditions: the original hard-drawn state, annealed, and hardened by stretching after being annealed. The effects of stress have also been examined (1) by loading and unloading magnetised nickel wire with weights which produced cyclic variations of longitudinal pull, and (2) by magnetising while the wire was subjected to a steady pull of greater or less amount.

The results confirm and extend Sir William Thomson's observation that longitudinal pull diminishes magnetism in nickel. This diminution is surprisingly great: it occurs with respect to the induced magnetism under both large and small magnetic forces, and also with respect to residual magnetism. The effects of stress are much less complex than in iron, and cyclic variations of stress are attended by much less hysteresis. Curves are given to show the induced and residual magnetism produced by various magnetic forces when the metal was maintained in one or other of certain assigned states of stress; also the variations of induced and residual magnetism which were caused by loading and unloading without alteration of the magnetic field. Values of the initial magnetic susceptibility, for very feeble magnetising forces, are stated, and are compared with the values determined by Lord Rayleigh for iron, and the relation of the initial susceptibility to the stress present is investigated. The paper consists mainly of diagrams in which the results are graphically exhibited by means of curves.

* Abstract of a paper read before the Royal Society, May 17th, 1888.

AMERICAN NOTES.

By DAS TELEPHON.

BY invitation of Mr. A. G. Davis, President of the Viaduct Manufacturing Company of Baltimore, I came to this beautiful city of half a million of inhabitants to witness a trial of a car propelled by electricity on one of the numerous tramways in this city of hills and valleys.

In May, 1882, the steamship *Labrador* arrived from Europe at New York, on which was used an electric storage battery, or electrical accumulator, for the purpose of the electric lighting of the steamer. Mr. A. G. Davis having heard of its successful operation on that steamer proceeded to New York, and purchased from the owners the patent rights for the States of Maryland, West Virginia, and the District of Columbia. At that time Mr. Davis was the executive head of the Bell Telephone Exchange Company in Baltimore, and from that period he has given much of his time and expended large sums of money in bringing it into successful operation.

In 1883 the Viaduct Manufacturing Company was incorporated principally for the development and subsequent manufacture of the electric storage battery under the "Faure" patent.

After a series of experiments running through from 1883 to 1887 this company decided to have a car constructed suitable in all respects to the present wants of this community, to be equipped with the Faure storage battery and the Sprague electric motor. This company has worked patiently and intelligently for five years to accomplish the end which they seem now to have attained, and through their perseverance Baltimore city is entitled to the privilege of being the first to demonstrate the solution of the greatest electrical problem of the day.

During the trip the car surmounted, without any apparent difficulty, the following grades:—

1	grade	450	feet	long	of	6	feet	per 100
1	„	600	„	„	„	6	„	„
1	„	300	„	„	„	3½	„	„
1	„	200	„	„	„	1½	„	„

And curves:—

4	of	29	feet radius
6	„	34	„ „
3	„	45	„ „
8	„	50	„ „

The car was stopped frequently on the middle of the steepest grades, and resumed its onward movement with the greatest ease. It was also stopped on the curves, and also then resumed its onward march.

The commutator is placed on the front platform of the car, and by means of it the electrician in charge applies just as much of the electric current as is required to meet the various grades and curves. At no time was *all* the power applied.

The weight of the car is		7,000 lbs.
„ „ two motors and gearing ...		1,600 „
„ „ storage battery		4,400 „
Total weight		13,000 lbs.

There were 45 full grown persons in the car—the seating capacity is 24, but its full capacity (standing room) 75; the speed of 12 miles an hour was obtained. One charge sufficed for eight trips of five miles.

I believe that the use of the electric motor and storage battery must supersede horse traction on tramways.

I shall endeavour to obtain some further statistics about this car, its cost of construction and expense of running.

It is announced that the owners of the Drawbaugh telephone patents have filed a motion with the clerk of the Supreme Court of the United States to obtain a rehearing of the great telephone case decided on March 19th last. Your readers will have read in your REVIEW the report of the decision of a majority of the court, and the opinion of a minority, which latter was that in their opinion Drawbaugh invented the magnetic telephone before Bell. I do not think that the court will grant the motion, and if it should do so I do not think the court will reverse its decision. In my opinion the evidence submitted by the owners of the Drawbaugh invention was concocted by Wall Street stock-jobbers.

A company owning the "Bonta" telephone patents are attempting to foist upon the public "Bonta's" transmitter as a *make* and *break* instrument, since the decision of the Supreme Court that Bell's patent of 1876 controlled all ways of using an undulatory current in a closed circuit. Your REVIEW of last September (I think) contained a statement by your quondam correspondent setting forth fully the construction and operation of Bonta's instrument, showing it to be a *carbon microphone* acting in a closed circuit.

Baltimore, *May 12th*, 1888.

INCANDESCENT LAMP PATENTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* HOLLAND AND OTHERS.

(*Before* Mr. JUSTICE KAY.)

(*Continued from page* 545.)

THURSDAY, MAY 17TH.

THE ATTORNEY-GENERAL said, with reference to what fell from his lordship on the previous day at the conclusion of Prof. Dewar's evidence, he had carefully looked at the shorthand note of what was said, and thought it quite possible that he had attached undue importance to what passed. He hoped to be able to prove all that was necessary with regard to the brass box.

Mr. JOSEPH WILSON SWAN, examined by the ATTORNEY-GENERAL, said: I am the technical director of the Swan United Electric Light Company, having held that post ever since the formation of the company. I formerly, from about 1860, carried on business in partnership with Mr. Mawson, as a chemist, in Moseley Street, Newcastle. It was a very varied business, but the principal feature was the supply of chemical, philosophical and photographic apparatus, and of chemicals for analysis. The supply of electrical apparatus also formed a very important part of the business. My first thoughts on the subject of attempting to produce light by electricity arose from my hearing a lecture at Sunderland, and very soon after at Newcastle, by Mr. Staite. That was in 1845 or 1846. Very soon after that I began to work with electrical apparatus, and about 1848 I carbonised strips and coils of paper in charcoal powder in a potter's kiln belonging to Mr. Wallace, of Forth Banks, Newcastle. I packed these strips and coils in charcoal because I had sufficient chemical knowledge to know that that would prevent the burning away of the paper. I carbonised sometimes in a Hessian fireclay crucible and sometimes in common earthenware jars. I had the paper in straight strips and

also cut in the form of flat arches, and in ringlets. I tried to render these strips and curls incandescent in a vacuum after I had carbonised them, placing them under the bell-shaped receiver of an air pump for that purpose. I did not succeed, and do not remember doing anything else at that time that bears on the question. I took the matter up again about 1860, doing very much the same thing, except that I made the pieces of carbon smaller. I had at this time a better air pump, the best mechanical air pump that then existed, lent me by its inventor; I also had a considerably larger battery power. I did now succeed in making a flat carbonised paper arch bright red hot under the receiver of the air pump, and also in a specially shaped vessel. The carbon bent and broke on touching the sole of the air pump plate. I had a special sole-plate made which would let the wires go through, and insulated. I did not go any further then. Some time in the autumn of 1877 I was introduced to Mr. Stearn, who was a clerk in the branch Bank of England at Liverpool. I learnt that he was very successful in the use of the Sprengel air pump, and that he was making radiometers and vacuum tubes of various kinds. My connection with Mr. Stearn continued through the years 1877, 1878, 1879 and 1880, he residing during all that time at Rock Ferry, near Birkenhead, and I at Newcastle. When we did not visit each other we communicated by letter. I have kept a great many, if not all, of Mr. Stearn's letters, and I have the originals here. Mr. Stearn has told me that he has not kept my letters. I am able from his letters, as well as from my own memory, to fix the dates of certain things that happened in the years during which our connection lasted. When I was introduced to Mr. Stearn, I explained to him what I had done in my previous experiments, and asked him if he would mount strips of carbonised paper for me between platinum wires, put them in glass bulbs, and exhaust on the Sprengel pump. He agreed to do so, and at the end of 1877 I sent him some carbonised cardboard strips. These had been carbonised in an earthenware vessel at the pottery kiln of Mr. Patterson at Gateshead. They were packed with charcoal powder, and were in the first instance simply strips about two inches long. I think they varied from one-eighth to one-quarter of an inch in width, and in thickness from the thickness of stout paper to that of thin card. The drawings [put in] of tubes in which the carbonised strips were placed were made by the glassblower who made the lamps at that time. I find from Mr. Stearn's letters that he made the first attempt to mount some carbonised paper strips on October 30th, 1877, and the next on November 1st. I remember one or two lamps of the first form, like the sketch marked 14, coming back from him. To the best of my recollection I was not able to make those lamps incandescent. The contact was very bad between the carbon strip and the platinum wires. In another case two strips were held by one end to the platinum wires and overlapped each other at the other ends, the object being to get over the difficulty that we had in making a good contact, and also to provide more elasticity. This mode was devised by Mr. Stearn's assistant, the glass-blower. In February, 1878, I had a straight strip mounted in a cleft produced by a saw cut in the ends of the platinum wires. I do not think I was able to raise that lamp to incandescence. The next lamp was a strip of carbonised paper or thin cardboard which had been completely electrotyped with copper by myself. It had a strip of platinum foil of about the same width as the strip of carbonised paper, hard soldered, with brass solder, at each end. I sent two or three filaments mounted in that manner to Mr. Stearn, and he had them mounted in a globe of glass. After mounting, having previously protected the joint with some varnish, he put acid into the bulb and dissolved the copper away. The object of electrotyping was to make a good contact between the carbon and the platinum. I believe I received back two lamps of this form, one a vacuum lamp, and the other open and without the copper being dissolved away. It was left open for me to do that somewhat delicate part of the operation and to fill it with nitrogen or anything I might choose to fill it with. I remember the vacuum lamp having the current sent through it and becoming incandescent; it lasted for perhaps half-an-hour and then broke. I do not remember what was done with the other lamp, but I know that I did not make a successful lamp of it. The night before my lecture at Newcastle in February, 1879, I received the lamp known as F. J. B. 1. The thin round carbon pencil in that lamp I received from Carré, of Paris, through Breguet. I had had a lamp exactly like this before—on December 26th, 1878. I sent a very strong current through that one, and made it so hot that the carbon bent very appreciably; the platinum supports were melted and the carbon dropped and fell into the tube, unbroken, but bent, and having an appearance of semi-fusion, a bright appearance which it had not before. I believe I first showed that lamp at a meeting of the Chemical Society of Newcastle in December, 1878, and then gave it to Mr. Proctor. There was a fire at my place on January 17th, 1880; I have an exceedingly clear recollection of the date. I experimented, but not continuously, during the year 1879, in conjunction with Mr. Stearn, and received from him certain lamps, the dates of which I can fix by the letters I also received from him. I certainly did not make a thread lamp before 1880; I think towards the middle of that year. It is not true that in 1879 I had thread lamps, either with or without the second loop, running in my engine-house. Prior to the fire, F. J. B. 1 was the most successful lamp I had produced. In 1879 we were struggling to get lamps which would remain permanent, which would not break down, and our experiments were directed to that point, to produce an incandescent carbon lamp that would be durable. The great difficulty that we had to contend with was the making of a good contact between the carbon conductor and the metallic back, and almost all our experiments were directed to conquering that difficulty. B. S. P. 3 was made, I think, in 1879, after the lecture at which F. J. B. 1 was shown. The copper spiral inside that lamp (B. S. P. 3) arose from our using the thicker carbon conductors, which were easier to manipulate, and which required a very much stronger current than carbonised paper strips required; and therefore the heat communicated to the conducting wires was greater. The object of the spirals was to carry off the heat. The burner in that lamp is a straight Carré carbon. In this lamp, because the carbon conductor was somewhat thick, copper wires and not platinum wires were used, and in order to make a perfectly air-tight joint between the wires and the conductor a platinum cap was used between the two, the platinum cap being fused to the glass and the platinum soldered to the copper. In another lamp there is a copper spiral round an earthenware tube; that was to give stability to the copper wires supporting the carbon. The straight conductor at the top is a rod of Carré carbon, and the cones at the top are probably pieces of carbon electrotyped. It has the same method of bringing in the wires with the platinum caps, and with the same object. These fragments [put in] are the remains of a lamp in which the conductor was of hairpin-form Carré carbon bent into the form of an arch. I have here a model of the hairpin-shaped carbon, made of black bronze. This was made from recollection, but recollection assisted by various things, the remains of that lamp being amongst the things.

The ATTORNEY-GENERAL: Will you look at that letter? Does that letter contain a picture of the Carré carbon as described by Mr. Stearn, and does it accord with your recollection of what you sent him?—Yes.

I wish to read the letter. It is dated November 26th, 1879, and is from Mr. Stearn to Mr. Swan:—"My dear Sir,—Yesterday evening and the evening before I again attacked the problem of the lamps. On the first occasion I had one of these first sent, the form of mounting, fig. 1, the carbon being mounted horizontally. The exhaustion was carried on from 7 to 1.30, at which time the lamp was sealed off, small quantities of gas still continuing to be evolved, the current from nine large Bunsens being constantly kept through the carbon. The pencil was white hot, and the holders bright red, the wire which enters the carbon being also dull red for ¾ inch from the carbon. No change was visible until after the lamp had cooled, but since then an evident partial disruption between the wire and the carbon has taken place inside the carbon at *a*, for on making contact with the battery it does not now become incandescent for a few seconds, during which there is a preliminary fizzing. The wire then swells, and the light is steady for the remainder of the time. Last night I exhausted one of the hair-pin form, mounted thus: . . . . . The light was apparently rather brighter than the other, and was perfectly steady from 7 till 11, after which time it went out momentarily several times, and then again regained steadiness; the cessation and re-establishment of the current being effected without any interference with it on my part. The volumes of gas given off by this one was enormously greater than in the former case, quite enough, I should think, to have raised the whole to nearly atmospheric, or at least to half atmospheric, pressure if not removed, and it continued even till the last to give off much more than the former lamp. About half-an-inch of the carbon blocks was red hot, and the large supplies of gas evidently came from there, and this indicates that much more heating power is necessary in the preparation, for the application of the engine will no doubt evolve as much more from those parts of the carbon which the smaller current does not heat. In order to observe the changes, if any, that went on, I projected the image of the carbon arch on to a screen across the room by means of a lens. This revealed a most remarkable difference between the two carbons. The straight piece was simply a line of light; the arched form was most beautifully mottled in white and black all over. I photographed the image, which I will send you if it developes. I could see no change in the position of the spots or of the image of the carbon. I think this seems to indicate that they are quite reliable at such temperatures as these. The behaviour of the two lamps is diametrically opposite. The first does not make contact well till hot, and is then steady. The other flashed out instantly, and not till it had been hot some time did the temporary break occur. This seems to point to the cause I predicted, namely, loosening of contact by expansion of the platinum wire that binds the blocks together. Perhaps if the wire itself were heated in the same way it would not be so liable to change by temperature. The contraction it undergoes in expelling the occluded gas might bind the carbons closer together afterwards, but this is very difficult of application." I ask your lordship to look at that while the exhibit is before your lordship. (To witness.) That model had been prepared by your direction?—Yes.

What was the object of those two legs in that form?—It was merely a method of mounting that the glassblower found more convenient than any other.

Will you now produce a lamp which has not yet been published?—Yes.

When did you make that with reference to the fire?—That was made after the fire to the best of my belief. The conductor is carbonised paper, the paper being in the first instance parchmentised.

There is a copper spiral inside it?—Yes.

What are those little fluffy bits, which look like wool, inside?—It is glass wool which has been stuffed down the stem in order to keep the conducting wires steady in the shank of the tube, and

has come out of its place accidentally. That was made before I had made any carbonised thread lamps, and after January, 1880.

You have heard Mr. Heaviside and Mr. Proctor say that to the best of their belief they saw thread lamps in 1879. Is that a mistake, or not?—It is an entire mistake.

What is the total number of lamps you got in 1879 altogether?—I have looked through the correspondence, and as far as I can gather from it, and from my own recollection independently of it, I think the outside number was 20, but there may not have been more than 10. These were received two or three at a time from Mr. Stearn. Nobody else was making lamps for me in 1879.

Did they come by hand, by rail, or by post?—I think we did make some experiments with the post, but very soon shifted to carriage by railway.

Did any of the lamps that came to you arrive broken?—Yes, breakages were frequent.

As soon as you began your thread lamp, did you use it parchmentised or not?—It was always parchmentised.

Was it successful?—Yes.

How soon after you had your parchmentised thread lamps did you exhibit them?—I think not before the middle of 1880.

How long after you began to make parchmentised thread lamps was it before they became a success?—They were almost immediately a success.

A matter of weeks or days?—A matter of weeks, because there was always a considerable delay between my sending carbons to Mr. Stearn and my receiving the mounted lamps back.

When you had started your parchmentised thread lamps did you have considerable numbers made?—At first, no; but very quickly better means were used for increasing the number, and very soon we did make a considerable number, towards the end of 1880.

Where did you run them?—In Moseley Street premises, chiefly, in the engine house. I remember one being run at my own house. I remember the engine being put up about March, 1879. I remember an extra flywheel being put up for the purpose of making the bearing upon the axle more equal, and possibly, I am not sure that I am right, but I think I am, for driving a second dynamo.

A strap coming from each of the flywheels?—Two flywheels and a strap from each flywheel going to a second dynamo. The second flywheel was more particularly called for by the necessity for the second strap.

Do you remember the countershafting being put up?—Not very clearly.

Have you Mr. Ridley's bill for it?—Yes.

Produce it, please.—It is September 1st to 11th, 1880: "Time men, 108 hours, on countershafting, wheels, &c."

Just see whether on the same bill there is a charge for wiring.—I believe there is. It is August 30th: "38 hours, fixing machines and wiring, £1 11s. 8d."

What were those wires for?—To the best of my belief they were the wires that were used in supporting the lamps—bringing current to the lamps, the first lamps that we did exhibit in the engine room.

Look at that letter of Messrs. Crossley's of September 4th, 1880. Do you remember soon after you began to run any difficulty arising from unsteadiness?—Yes. It was an irregularity in the speed of the engine, the well known irregularity incidental to the use of the gas engine, and we had a difficulty in correcting that irregularity. I corresponded with Crossley's on the subject. We found the difficulty immediately we began to run.

Mr. Ridley stated that he thought the four standards put up in November were put up to protect the people from the countershafting and the belts. Is that correct?—It would be more correct to say they were put up to keep the people from getting near the belts.

Had it anything to do with running for lighting or not?—No. It had to do with the general running of the engine when it was used, not for the lighting, because the lighting had not commenced.

What sort of work did you do for your customers in connection with electrical matters other than lighting?—We supplied dynamos and arc lamps, and electric signalling apparatus and bells for collieries, and various electrical apparatus generally, independent of electric lighting in particular.

Did Mr. Heaviside and Mr. Proctor see the lamps in Moseley Street in 1880?—Probably.

Do you remember Mr. Stearn sending you his account to the end of the year 1879?—Yes.

It is under the date January 1st, 1880:—"I am sorry to say the cardboard filament did not live more than ten minutes after reaching me. The glassblower was here, and in straightening the wires at the bottom to put through the platinum caps the carbon broke. The wires he says he cannot manage, bent as they were, and he prefers them longer. I have only one pair of caps. I suppose you wish to dispense with these, but I do not think with such a current and such thick wires it would be safe to do so. The enamel, if you will send me, will try, but remember that every fresh experiment necessitates considerable delay in awaiting the result. The caps and soldered joints we know will do. I return the fittings for another filament to be replaced. Please forward the enclosed order to the firm for aluminium." "Paid glassblower, March 26th, 10s. Paid Marr for soldering, &c., 5s. Paid guard for carriage to Newcastle, 2s. 6d. April 27th, paid glassblower 5s. Mercury and binding screws for batteries, 9s. December 20th, carriage of batteries, 3s. 10d. December 31st, paid glassblower 12s." All your lamps were blown for you by Mr. Stearn?—Yes.

Did you ever produce a lamp with a double turn in it before you had the thread lamp?—No.

Did you go over to Mr. Stearn's?—Yes, two or three times. I was there at the time of the fire, and received a telegram there telling me of it.

Had you seen at Mr. Stearn's any experiments, or had you only tried lamps when they had come back to you?—Yes; I was in the act of seeing one of the lamps run when the telegram was put into my hands.

What sort of lamp was that?—I believe it was a Carré carbon lamp. I have not a very clear recollection of it.

Are you able to say distinctly whether it was or was not a thread lamp?—Yes, very distinctly that it was not.

At your visits to Mr. Stearn had you ever seen, prior to the fire, any thread lamps?—No, I think not; I am sure I had not.

Now, speaking of lectures and the exhibition of lamps to the public, you remember the lecture you delivered at which you explained F. J. B. 1 or a lamp like it?—Yes.

After that time you went on making the experiments which I have been examining you upon?—Yes.

What object had you in those experiments?—To find a practicable incandescent carbon lamp. The particular point that I was searching to prove was the means of making the carbon permanent during incandescence—a lamp that would be durable.

I think you yourself experimented as to driving out the occluded gases, did you not?—In conjunction with Mr. Stearn, yes.

You filed a specification, I think on January 2nd, 1880, No. 18, for driving out occluded gases from carbon by running on the pumps?—Yes.

I need scarcely ask you, but I must in form, were you aware at the time you filed your specification that that had actually been described in a specification of Mr. Edison's of November, 1879?—No; I knew that Mr. Edison had made experiments on platinum wires.

Sir HORACE DAVEY: I do not think that is the right date.

The ATTORNEY-GENERAL: It does not matter what date in 1879 it was. Was that the patent on which the Swan Company attempted to take proceedings in the Woodhouse and Rawson action?—I think it was one of the patents.

Cross-examined by Sir HORACE DAVEY: I did not catch the first answer you gave the Attorney-General. Are you at the present time a director of the Swan and Edison Company?—Yes—I beg your pardon, of the Swan United Electric Light Company.

I mean the company that is sueing?—No, I am not a director of that.

The ATTORNEY-GENERAL: The Swan United Company is quite a different thing.

Sir HORACE DAVEY: Which company are you a director of?—The Swan United Company.

You must excuse me if I cannot follow all the circumvolutions of the company.

The ATTORNEY-GENERAL: There are no circumvolutions.

Sir HORACE DAVEY: There are a good many. Does the Swan United Electric Light Company, Limited, hold a large number of shares in the company which are at present plaintffs?—Yes.

And you personally hold a large number of shares in what I call the amalgamated company?—Yes, through my interest in the Swan United Electric Light Company I do.

Mr. JUSTICE KAY: Not personally? Are you personally a shareholder in the plaintiff company?—The shares, my lord, are held in trust by certain of the directors.

Sir HORACE DAVEY: I do not want to inquire into any of your private matters, Mr. Swan. That is not my object at all. But you have a large interest in the plaintiff company, directly or indirectly?—Yes.

That is quite sufficient for my purpose. And I think you hold some professional position in the plaintiff company, do you not, as scientific adviser, or something of that kind?—I do not think I hold any regular office in the plaintiff company. I receive no notice of their meetings, and I think I have never been elected a director in any formal way. My position is a somewhat doubtful one. I hold no regular post in the company. If I could render any service to the Edison and Swan United Company I would very readily render such service, but I hold no office of a regular sort in that company.

I think the present company, which I call the amalgamated company, was the result of an amalgamation of the Edison Electric Light Company and the Swan United Electric Light Company, was it not?—Yes.

Was not that amalgamation the result of an action brought by the Edison Company against your company?—I believe it was.

Do you not know it was?—I know other considerations entered into the question besides that.

The ATTORNEY-GENERAL: There were cross-actions.

Sir HORACE DAVEY: Then I will say the result of litigation?—I think that was one of the reasons.

There was litigation going on between the Edison Company and the Swan Company?—Yes. There was a doubt on the part of the Swan Company as to their legal status.

No doubt I suppose on the part of the Edison Company of their legal status?—I am afraid I cannot answer for the Edison Company.

I think the share capital of the amalgamated company was divided between the two companies, was it not?—Yes.

A large portion of it?—Yes.

Do you remember the number of paid-up shares, or the amount in paid-up shares, which the Edison Company got?—The capital of the two companies was divided.

The ATTORNEY-GENERAL: I do not see what it has to do with it, but you may state it.

Sir HORACE DAVEY: I daresay you do not. That very often happens. But you will see presently what it has to do with it. Is it not a fact that the Edison Company got 45,000 shares fully paid up, or partially paid up, and that the Swan Company got 61,400 shares?—I cannot speak to the fact. My impression was that it was 60,000 and 40,000.

You are very nearly right; I will take that proportion. I think the Edison Company was suing the Swan Company for infringement of their patent of November, 1879, were they not?—I think they were.

You know they were, do you not?—No; I do not distinctly call to mind the position of the litigation at that moment. I believe there was suspended litigation.

There is one question I should like to ask you before I go more into detail. You told my lord that that lamp F. J. B. 1 contained a Carré carbon?—Yes.

Do you know how the Carré carbons are made?—No, I do not know from absolute knowledge. I think I know. I have an idea on the subject, but I do not know absolutely.

Perhaps you will be able to answer this question. Do you not know that the Carré carbon received its present shape before carbonisation?—No, I do not know, but I should imagine that it is probable.

How long have you thought it probable?—I have never thought otherwise.

You were present, I think, during the whole of the Woodhouse and Rawson trial in Court?—During most of the time.

And you were present, I daresay, and I daresay enjoyed, as we all did, the opening speech of the learned counsel for the plaintiff in that action, the present Attorney-General?—I believe I did experience the same sense of pleasure. That was quite general.

Perhaps you enjoyed it more than we did. It made us tremble; but one can admire a speech from one's opponent. You remember F. J. B. 1 was produced at that time?—Yes.

Do you remember hearing the Attorney-General in his opening speech, of course from instructions, tell the Court that that carbon ——?—May I make a correction?

Certainly.—Thinking back a little, I do not think I was in Court when the Attorney-General made his opening speech.

Then you did not hear his suggestion that the carbon in F. J. B. 1 had been sweated or filed down with a saw or file, or other mechanical means?—I do not believe I did hear that.

Were you in Court when Sir Frederick Bramwell gave his evidence?—Yes.

Do you remember F. J. B. 1 being produced to Sir Frederick Bramwell?—I think I do.

You take some interest in that lamp I dare say?—Yes.

Do you remember this question being put to Sir Frederick Bramwell: "I do not know whether you can tell from the view whether that" (that is the carbon in what we then called the Swan lamp) "has been worked down from a thicker piece of carbon or not?—I have no doubt it has. The appearance is quite consistent with that." Do you remember Sir Frederick Bramwell saying that?—Yes, I remember that.

And Mr. Justice Butt, who tried the action, adding: "You believe it has been worked down from a thicker piece of carbon of greater dimensions?—Yes. That is to say, this particular pencil of carbon has not been carbonised in its present form, I believe. I can only speak from my belief in the matter. I cannot speak with certainty. I should be surprised to hear that it had." Do you remember that taking place?—I remember that quite well.

Did you tell the plaintiff's solicitors then that they were under a mistake; that it was a Carré carbon?—No opportunity occurred. No question as to it arose.

You did not think it important to correct that?—No, I did not think it necessary at all for me. At that time I was subpœnaed by the other side, and in danger of being called at any moment, and I did not think it at all part of my duty to make any communication upon the subject.

The ATTORNEY-GENERAL: There was no communication from Mr. Swan to us at all.

Sir HORACE DAVEY: You did not, as a matter of fact, correct Sir Frederick Bramwell's misapprehension?—As a matter of fact I did not.

But you knew, did you not, that it was made an issue of extreme importance in that action?—No, I did not know that.

Do you remember Mr. Edison's telegram in October, 1878, which was sent to this country?—I cannot say that I remember it. It is extremely probable that I knew of it.

Do you remember delivering a lecture—I think you have already told us—at Newcastle on February 4th, 1879, on the subject of electric lighting?—Yes.

With Sir Wm. Armstrong in the chair?—I remember it quite well.

Do you remember saying this:—"The subject for some considerable time before had been gradually acquiring importance and gaining more and more attention both from scientific and practical men; but the crisis, if he might so call it, was reached in October of last year." That would be 1878?—Yes.

. . . . "When the following telegram from Mr. Edison to his London agent was fulminated:—'I have just solved the problem of the sub-division of the electric light indefinitely.' This was immediately followed by the telegram:—'When the brilliancy and cheapness of the light are made known to the public, which will be in a few weeks, or just as soon as I can thoroughly protect the process, illuminating by carburetted hydrogen gas will be discarded. With 15 or 20 of these dynamo-electric machines, recently perfected by Mr. Wallace, I can light the entire lower part of New York City, using a 500 horse-power engine. I propose to establish one of these large centres in Nassau Street, whence wires can be run up town so far as the Cooper Institute, down to the Battery, and across both rivers. These wires must be insulated and laid in the ground in the same manner as gas pipes. I also propose to utilise the gas burners and chandeliers now in use. In each house I can place a light meter, whence these wires will pass through the house, tapping small metallic contrivances that may be placed over each burner. Then housekeepers may turn off their gas and send the meters back to the companies whence they came. Whenever it is desired to light a jet it will only be necessary to touch a little spring near it. No matches are required.' The effect of the publication of these telegrams was electrical." That was the platinum invention of Mr. Edison which was referred to in that telegram?—Yes.

And the platinum lamp proved a failure?—I am not able to speak as to that.

It has been superseded by the carbon lamp, at any rate, has it not?—Yes.

On December 19th, 1878, you lectured before the Chemical Society at Newcastle, did you not?—I made a very slight communication to the Newcastle Chemical Society.

And you produced a lamp, did you not?—Yes.

I think Mr. Proctor told us it was a broken lamp of the same type as F. J. B. 1?—My recollection as to that entirely coincides with that of Mr. Proctor.

Then I think the next lecture you delivered was a lecture at Sunderland?—Yes. I exhibited several lamps at that lecture; not incandescent lamps.

You exhibited lamps of different types, including an incandescent lamp?—I am not sure as to the incandescent lamp; but I think it is extremely probable that I did show an incandescent lamp with a Carré carbon.

Of the same type as F.J.B. 1?—No; I don't think I had a good lamp of that type. If I showed one at all it was probably a straight carbon lamp of one of the other forms.

Are you not sure that it was a lamp with a straight cardboard burner?—I am quite sure that it was not.

You had previously, had you not, made, or had made, lamps with a straight burner, consisting of a straight strip of cardboard carbonised?—I had made some. I think I had two made; but excepting the very early ones, which I don't think incandesced at all, the only other carbon strip lamps that I had were the two that I specifically described, and which came to me, to the best of my belief, on the night before my Newcastle lecture.

I am instructed that you produced at the Sunderland lecture an incandescent lamp which was burned through the lecture and put out at the end of it?—It was an entire mistake. I did not. I will answer that more widely. At none of my lectures did I ever show any kind of incandescent lamp that burned during the whole of the lecture.

The Newcastle lecture, the next in date, was on February 3rd, 1879. I think you said you were under the impression that you produced the lamp known as F. J. B. 1 there?—I believe that is the lamp. If not that, one exactly similar.

And that lamp was introduced and burned during the whole of the lecture?—No.

At some period of the lecture?—Yes, at the close of the lecture, or towards the close.

I am instructed that it was for about 20 minutes?—For 10 or 20 minutes. It is very improbable that it was so long as 20 minutes.

Then it was put out. You turned the electricity off?—Yes.

During the time that it was burning, did it give a good light?—Yes.

At the next lecture, at Gateshead, on March 12th, 1879, you again produced the same lamp?—Yes.

Did the lamp burn successfully at that lecture?—Yes, during the time it was lighted.

Did you in addition to exhibiting a lamp at three of those lectures, also exhibit some unmounted carbons?—I have not the slightest recollection of doing that.

Let me suggest to you that you exhibited some horseshoe-shaped carbonised cardboard or paper carbons?—I am able to say that I did not.

You were making carbonised horseshoe-shaped cardboard or paper carbons at that period?—No.

None whatever?—None whatever.

During the year 1879?—None whatever.

Will you undertake to say that you did not make, or have made for you, any horseshoe-shaped cardboard or paper carbons in the year 1879?—Yes; without the slightest hesitation I say I had not.

Or mount any carbons of that description in lamps during that year?—Or mount any cardboard carbon lamps during 1879 of that shape.

Then do you suggest that Mr. Heaviside is mistaken?—I have no doubt of it whatever.

When he says that he tested for you during the months of August, September and October, lamps of a horseshoe shape—I am not speaking of the loop lamps of a horseshoe or arched shape—made, as he believed, of cardboard or paper?—Yes. I have no doubt whatever that he is entirely mistaken, and that if he did see any horseshoe shape or hairpin shape carbons at all in that year they were the Carré carbon hairpin lamps.

Did you use horseshoe shape carbons during the year 1879 in incandescent lamps?—Probably towards the end of 1879. I did make some hairpin shaped. I am depending entirely upon Mr.

Stearn's letters for my recollection on this point, and I should have to refer to them again to be perfectly sure as to the dates when the first hairpin carbon lamps were made.

Are you prepared to say you did not have them made in the period I have mentioned?—No, I am not prepared to say I did not.

Did you not during the period I have named send lamps with hairpin-shaped carbons in them to Mr. Heaviside to be tested?—I do not know.

Do you not think it probable Mr. Heaviside may be under a mistake as to whether they were made of carbon or not, because he said he did not know himself, but took it from your information, but do you not think it probable that the lamp which he refers to as having been brought to him to be tested with horseshoe carbons had that hairpin Carré carbon in them?—I think that it is just as probable that he is mistaken altogether; as to his seeing a loop at all he is absolutely wrong.

We are not talking about the loop.—He is absolutely wrong as to seeing any lamps with horseshoe carbons made of carbonised cardboard, and if his recollection is so defective——

I am taking you away from that, if you will be kind enough to follow me. Mr. Heaviside's impression is that they were carbonised cardboard, because he thinks you told him so.—I haven't any confidence whatever in his recollection.

Excuse my saying that that is, of course, for his lordship to judge. Are you prepared to say that you did not send lamps with hair-pin shaped carbons in them to Mr. Heaviside during that period?—No, I am not prepared to say that, but I think it extremely doubtful.

I will ask you to take that model of a hair-pin shaped model in your hand. Do you not think that a very fair filament?—I am not an authority on filaments.

Mr. Swan! Is there any gentleman in the world who has delivered so many lectures about filaments as you have? Tell me fairly, is not that a very fair filament?—You know perfectly well that the word filament has come to have a technical and special meaning, and it is now used as simply equivalent to a conductor, without reference to size. If you ask me if this is a good specimen of a filament in that sense I say that it ——

You say what?—That really is a question extremely difficult to answer.

I asked you a very fair filament. I was not enthusiastic in its praise.—I really cannot answer the question in that form, because it is not a carbon filament at all. It is really a piece of copper wire, and not a carbon.

But that is only a model. The thing of which that is a model, and intended to represent, was a carbon one?—If you ask me to use this as a means of defining what in my opinion is a filament ——

But I am not asking you that. You shall answer my question or not, as you like. Was not the conductor, of which that piece of copper wire is a model, a very fair filament as filaments go?—I cannot answer the question.

What should you say was the diameter of that?—That is $\frac{1}{25}$th of an inch.

In 1879 was not that a very fair filament?—The word "filament" was not used at that time. There was no fair or unfair filament at that time.

I think you were troubled with smoke in your lamps, were you not?—Yes; one of the difficulties we had to contend with was the blackening of the bulb.

I suppose you ordered the hairpin-shaped carbons specially from Carré?—Yes, through Breguet.

And you used them for mounting in electric lamps?—Yes.

Did they burn successfully?—No, I cannot call to mind a single successful lamp made with those hairpin carbons.

Was not that on account of the occluded gas?—No, chiefly on account of the bad contact between the conductors.

You could not give me the date, I suppose, when you ordered those carbons?—Approximately, I think I can. I think it was in the spring of 1879.

And the date, approximately, when you received them?—I am sorry to say I cannot.

In the ordinary course of business it would be about a month or six week afterwards; that is to say, in the early summer of 1879?—Probably.

Have you any doubt that you received them then?—Yes, I have. The only thing I have to help my memory is Mr. Stearn's letters. I really have no recollection at all about ordering them or receiving them apart from that, and referring to these letters it seems that the first reference to them is at the end of 1879. Therefore I have a doubt.

To the best of your recollection you ordered them in the spring of 1879 and received them about a month or six weeks afterwards?—Possibly.

I suppose you did not order them until you wanted them?—No.

And did you not when you got them make use of them?—That is extremely doubtful, because I was engaged in other business that was very pressing. Mr. Stearn was often kept waiting a very considerable time before I sent him the material to carry out the experiments with. It is by no means certain that I immediately sent him the hairpin carbons after I had received them. It is highly probable to the contrary.

You told me just now that you had been troubled with smoke in your lamp, and that that engaged a great deal of your attention?—Yes.

With the assistance, I think, of Mr. Proctor?—No, I don't think I got any special assistance from Mr. Proctor with regard to that.

The merit is entirely due to you, Mr. Swan. I will concede that.—I did not imagine you were attributing any merit to me or otherwise.

I am going to attribute to you that you were the father of incandescent lighting.—It is better to clear up the point. The only assistance that I received from Mr. Proctor in connection with the blackening of the globes was the investigation of the nature of the deposit on the broken lamps shown at the Chemical Society.

Very well; I will take it that during the year 1879 your attention was much engaged on the question of the smoke deposit on the lamps.—I will not say much. It was part of the difficulties we had to contend with.

And I think on January 2nd, 1880, you took out a patent for the purpose of getting rid of that difficulty by the process known as running on the pumps?—Yes.

I will read you only the claim: "Having thus stated the nature of my invention and described the manner in which it may be carried into effect, I claim the production of an incandescent carbon electric lamp from which the air has been exhausted, while the carbon is in a state of incandescence, and which is hermetically sealed during the exhaustion."—What you claim there is a process of running on the pumps for the purpose of getting rid of the occluded gases?—Yes.

I thing on January 1st, 1880, you wrote a letter to a publication called *Nature*?—I remember I did write such a letter.

Under the heading "Edison's new lamp," you wrote: "I observe in *Nature*, vol. xxi, p. 187, a statement to the effect that Mr. Edison has adopted the use of carbon in his new electric lamp, and that the carbon he uses is charred paper or card of the shape of a horseshoe. Fifteen years ago I used charred paper or card in the construction of an electric lamp on the incandescent principle. I used it, too, of the shape of a horseshoe, precisely as you say Mr. Edison is now using it. I did not then succeed in obtaining the durability which I was in search of, but I have since made many experiments on the subject, and within the last six months I have, I believe, completely conquered the difficulty which led to previous failure, and I am now able to produce a perfectly durable electric lamp by means of incandescent carbon." Do you remember writing that?—Perfectly.

Is it a fact that during the previous six months before writing that letter you had been experimenting with cardboard?—No; the experiment I refer to in that letter, which led me to believe I had removed the difficulty that stood in the way of producing an efficient incandescent lamp, was the improvement of running on the pumps, for which I took out a patent immediately afterwards.

Did you not intend to convey to the public who read *Nature* that by means of your improvements you could produce an incandescent lamp with a horseshoe cardboard burner?—The letter is absolutely accurate in every particular. I do not know that I can explain it better than anyone else.

I will take your answer, because it is exactly what I expected you would give me. After having conquered the difficulty by running on the pumps, and getting rid of the occluded gases, were you able to say: "I have now completely conquered the difficulty which led to previous failure, and I am now able to produce a perfectly durable electric lamp by means of incandescent carbon." That, you say, is perfectly accurate?—That was my belief at the time I wrote that letter.

And was not your belief well founded?—I did look upon the improvement of running on the pumps as overcoming the greatest barrier in the way of success in making a thoroughly satisfactory incandescent lamp; but afterwards I found there were other difficulties besides that one to be conquered, and I think I was a little premature then in saying I had conquered all the difficulties.

Do you now say—do not understand me as in the least degree imputing any statement to you—but do you now say that the letter was not perfectly accurate, or that it was too sanguine, or—use your own expression?—I still adhere to my statement that it was perfectly accurate. The other difficulties to which I have referred are the difficulties of making good contact more particularly.

I quite agree; and a difficulty also in the material to be used and the carbon? That is a matter of extreme importance in electric lighting, is it not—the details in the manufacture of the carbon? I think on January 20th, 1880, you took out another patent, No. 250, for an improvement in incandescent lamps?—Yes.

"My invention relates to that kind of incandescent lamp in which light is produced by the incandescence of a continuous conductor of carbon enclosed in an exhausted glass bulb, and provides for increasing its durability." You did not mean to suggest at this date, did you, that there was any novelty in an incandescent lamp consisting of a glass bulb exhausted to a vacuum and with a carbon between leading wires which were sealed into a globe?—No; I did not intend to suggest that there was any novelty in the combination.

Now, did you intend to suggest that any particular sized carbon would constitute a novelty?—I made no suggestion bearing in any way on that point.

You say "The second part of my invention has for its object to prevent the rupture of the carbon within the exhausted bulb as the result of its unequal contraction. I have found that when the carbon employed within the lamp is in an horseshoe or arched plate produced by cutting out the arch or horseshoe-shaped piece from a sheet of cardboard, and afterwards carbonising it by heat, that the arch or horseshoe-shaped carbon so produced is

liable to become distorted and ultimately to break in consequence of the unequal heating of the inner and outer portion of the arch during the usage of the lamp." When did you find that?—I was there depending on my early experiment, which has been described, with the air pump.

How many years old were those experiments?—At that time perhaps 10 or 15 years old.

Then had you not tried an arch or horseshoe-shaped plate produced by cutting it out from a sheet of cardboard and afterwards carbonising it, since those experiments?—I cannot say that I had not produced any arches of any form since that experiment, but I had certainly not lighted any in lamps.

Had you not tried?—No.

You know you told us that one of the causes of your early failures was being unable to get a good vacuum because you had not the Sprengel pump with our friend Mr. Crookes's improvement?—Yes.

And you had not got the Gramme dynamo?—Yes.

Had you not tried your earlier experiment with the arch or horseshoe-shaped carbon after you had obtained those improvements in your vacuum and electromotive force?—No, not until the time I mentioned; not until 1880.

Do you mean to tell me that when you say "I have found" you are speaking of the experience of 15 years ago, before you got a proper vacuum or a proper electromotive force?—Yes; I was referring to that experiment, to my knowledge of what would happen if an arch-shaped piece of carbonised cardboard were used flatwise.

I need scarcely say you considered that a very valuable invention when you took out that patent?—Yes, I thought it was.

And it is a valuable invention, is it not?—I do not think I have the same——

You prefer your parchmentised thread, I believe, now?—Yes.

You were going to say that you had not the same respect for it as you had?—Yes; I was going to say something equivalent to that.

Parchmentised thread is now, I think, employed by the Edison Company?—The Edison and Swan Company.

Was not that parchmentised cardboard a valuable invention at that time, as far as you knew?—I think the fact of my applying for a patent implies it clearly.

Certainly. Now I will ask you, is it not exactly on the working out of these details, in which, if I am rightly instructed, you were the pioneer, that the success of the incandescent electric lamp depended?—That is a very large question, and one that involves very delicate considerations in the answering. It is difficult to answer that question.

I am addressing you as the most experienced man in the world on the subject.—I have no objection to saying that I think the success of the incandescent lamp does depend very much upon the exact working out of details.

Was not that in November, 1879, all that remained to be done to make the incandescent lamp a success?—No, I think not.

What else was there?—So far as I know——

I am asking, as I said, the most experienced person in the world. I ask what in your opinion remained to be done, except the working out of those details of manufacture, to make a successful incandescent electric lamp in November, 1879?—Nothing was required but the careful working out of details.

I suppose it is true that when the carbon is a horseshoe produced by punching from a sheet of cardboard, and afterwards carbonised, it is liable to become distorted?—That was my opinion at the time I took out that patent.

Is that your opinion still?—No, because I have the long experience derived from the use of just such horseshoe pieces of carbonised cardboard as I described in my patent.

Your next patent, I think, was a more valuable one still. It is No. 4,933, of November 27th, 1880, and is for parchmentised thread. What you claim there is "Forming the carbon or carbons of an electric lamp from the cotton thread converted by the action of sulphuric acid, and carbonised, substantially as hereinbefore described;" and, secondly, you claim a mode of making joints?—Yes.

You had, I suppose, before you took out that patent, been experimenting with a thread such as you describe in that patent?—Yes, to some extent.

And you had found that a thread, without the process which you describe as parchmentising, was not successful?—I am not sure that we did make any experiments with new parchmentised thread. I think I jumped from the parchmentised paper to parchmentised thread.

I think it was owing to this last patent that the great success of your lamps was due, was it not?—I think it was an advance in the construction of the lamp.

This was your own invention?—The application of the principle of parchmentisation to the material to be carbonised was my invention.

And you were not indebted to any other inventor, say Mr. Edison, for anything you describe in this patent?—I could not say I was not indebted to any other inventor. It is impossible to say to what outside influences one is indebted in carrying on work of this kind.

You are well acquainted with Mr. Edison's patent of November, 1879?—I do not think I became acquainted with it until long after it was published.

Can you point to anything in it which was new to you in 1879?—Yes, the method described there of producing filaments of carbon was new to me.

That is the putty method?—Yes.

Anything else?—The particular method of connecting the filament, when made, to the platinum wires, and the use of material to render the carbon porous, such as camphor or oxide of zinc.

Your view of what Edison describes there was that it was intended to render the carbon porous?—I think so; and to increase its resistance by shortening filaments that might otherwise have been too highly conducting. The whole form of the lamp was new to me; the close spiral was a novelty.

Are not the points which you have been mentioning matters of detail of construction?—I think the whole thing is a matter of details.

Was the general principle embodied in the second claim, the combination of "a carbon filament within a receiver made entirely of glass through which the leading wires pass, and from which receiver the air has been exhausted for the purposes set forth," was the principle involved in that claim a novelty to you?—If you allow me to put a particular construction on the word "filament," then I should say it was not a novelty. Using the words "carbon filament" in the sense of the illuminating part of the incandescent lamp, and without expressing any opinion as to whether it is a filament or not in the ordinary sense of the word, I say that the lamp which I exhibited, F. J. B. 1, is an identical combination of parts.

Was it or was it not a novelty to you that lamps of high resistance would be useful in incandescent lighting?—I knew that burners of high resistance would be useful in incandescent lighting, and I always contemplated using them when they were wanted.

You knew, did you not, that high resistance was to be obtained by diminishing the sectional area of the carbon?—Yes; not by that alone, but also by increasing its length.

How soon in the course of your experiments did you resort to electrotyping and hard soldering the ends of the carbon?—I have already said that I received, I believe, two lamps treated in that manner from Mr. Stearn on the day before my Newcastle lecture; I forget the date.

That made an efficient joint?—The lamps that were produced with that kind of joint did not behave at all satisfactorily.

Having cross-examined the witness upon various points in a lecture which he delivered before the Newcastle Literary and Philosophical Society in October, 1880, Sir HORACE DAVEY proceeded: Mr. Edison apparently was under the impression that he had invented or discovered the use of carbon in a vacuum?—In that very strong vacuum got by the Sprengel air pump. He is under that impression, and I think there is no doubt there was a mistake.

You pointed out in your lecture that that impression was erroneous?—Yes.

I think you read a paper before the British Association at York in 1881, in which you said: "Mr. Stearn undertook to mount some of my paper carbons in a good vacuum, and after many failures from carbons breaking, he at last succeeded in making some bulbs very highly exhausted, containing my paper carbons attached by electrically-deposited copper to platinised strips, which carried the current in and out of the lamp." When was that that Mr. Stearn succeeded in doing that?—The only experiment to which I can suppose that I referred is the one which I have described as being made in February, 1879.

You continue: "I had the pleasure in February, 1879, of showing to the president of the section (Sir Wm. Thomson) a lamp made in this way." Is that the fact?—There is some mistake there which I do not quite see my way to explain. Is it Sir Wm. Thomson or Sir Wm. Armstrong?

Sir William Thomson it is stated here, and I am told by a gentleman who was present that Sir Wm. Thomson was president of that section at York.—I did not show any lamp to Sir Wm. Thomson until 1880. It is very likely a mistake of the reporter. I did show a lamp to Sir Wm. Armstrong in February, 1879.

Of the description you mention here?—No; a lamp of the kind that has been produced in Court, F. J. B. 1.

You have told me that it is true that "Mr. Stearn undertook to mount some of my paper carbons in a good vacuum, and after many failures from carbons breaking, he at last succeeded in making some bulbs very highly exhausted, containing some paper carbons attached by electrically depositing copper to platinised strips, which carried the current in and out of the lamp?"—Yes.

You told me very fairly you think that refers to the experiments Mr. Stearn made for you in February, or in the early part of 1879?—Yes.

Do you not think it probable that it was in February, 1879, that you showed a lamp of that description either to Sir William Thomson or to some other gentleman, Sir William Armstrong, possibly?—No, I am quite sure I did not.

Probably you agree with the statement you are reported to have made that those bulbs were in fact made for you in the manner here described in the early part of 1879?—No.

I thought you told me you did?—With the exception of those I described. There were many things other than those I have described.

Is it the fact that Mr. Stearn did succeed after some failure in constructing bulbs such as those described?—Yes; he succeeded in particular in constructing a bulb which I have a clear recollection of trying.

And the description here given answers the description of the bulb you had in your mind?—Yes.

That, if I understand you correctly, was in the early part of 1879?—I am perfectly clear as to this——

Can't you give me yes or no?—I am perfectly clear of this that I did not show any bulb containing the carbonised paper carbon either to Sir William Armstrong or Sir William Thomson.

The question I asked you was, and I am sure you will give me an answer to it if your memory serves you, was it not in February, or in the early part of 1879, that Mr. Stearn made for you that bulb, or those bulbs, which are here described?—That is perfectly correct.

But you are in doubt, or rather you do not think that you showed it either to Sir William Thomson or anybody else?—I am not in doubt at all. I am quite sure I did not.

"In making these experiments I did not confine myself exclusively to the use of paper carbons. The lamp as constructed for me by Mr. Swan was extremely simple. It consisted merely of a highly-exhausted glass bulb into which were sealed, by fusion of the glasses, two platinum conductors supporting the carbon." That is a true description of the lamp you made?—Yes.

"This simple form of lamp," you go on to say, "I showed lighted at a lecture which I delivered before the Philosophical Society of Newcastle in February, 1879." That is a fact?—I showed on that particular date a lamp having that combination.

"The final result of our experiments was, that when the vacuum was good the carbon did not appreciably wear away, and that when the contact between the ends of the carbon and the metallic conductors was good the clips did not blacken. Henceforth it was possible to produce a durable electric lamp that emitted a steady light of moderate power. Very soon after this, and I am quite sure without knowing what I was doing, Mr. Edison produced a lamp identical with mine in all essential particulars. It, too, consisted of a simple bulb from which the air had been exhausted by the Sprengel pump, and which, like mine, had no screw-closed opening, nor complications of any kind, but contained simply the ingoing and outcoming wires sealed into the glass with the carbon attached to them." Do you remember that?—Yes, I remember that.

In the first place I will ask you whether the lamp produced by Mr. Edison, which you refer to there, is not made by him after his patent of November, 1879, and subsequent patents?—I should think it is.

Is it, or is it not, the fact that the lamp which Edison produced was identical with yours in all essential particulars?—I was referring to the combination of carbon, platinum and glass, and in so far as similarity of the combination in those lamps went I did look upon it as identical.

At that time you considered that Mr. Edison's lamp was identical with yours in all essential particulars?—No. I say in so far as it was of simple construction, a combination only of glass, carbon and platinum.

I do not want to be troublesome to you, but what you are reported to have said is that Edison's lamp was identical with yours in all essential particulars?—What I meant was in those particulars. I do not remember whether I used the words "in those particulars," or "in all essential particulars." It is probably correctly reported; that is certainly what I meant, "in those particulars," as an elementary combination.

Was that paper sent to you for correction, do you know, before it was published in the *Electrician*?—No, I do not think so.

Perhaps you sent your manuscript to the editor?—I do not know.

In a lecture which you delivered at the Royal Institution on March 10th, 1882, you said: "After much experimenting we arrived at the conclusion that when a well formed carbon filament is firmly connected with conducting wires and placed in a hermetically sealed glass bulb, perfectly exhausted, the filament suffers no apparent change, even when heated to an extreme degree of whiteness. This result was reached in 1878." Is that true?—Yes. (After a pause) I think it was saying too much to say that we had arrived at that result in 1878.

You do not suggest that the report is incorrect, do you?—No, I do not suggest that. We had, I think, very strong reasons at that time to anticipate a successful issue to our experiments.

After describing the lamp upon that occasion, you said: "Probably the first lamp having this elementary character ever publicly exhibited was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle, in February, 1879," and you described that lamp as having the elementary character of "a simple bulb pierced by two platinum wires supporting a filament of carbon," and that, in March, 1882, you no doubt considered an accurate description?—That was an accurate description of the lamp that I showed at my lecture, always provided that the word filament is understood in its technical sense, not in its general sense.

You formed a company called the Swan United Electric Lighting Company, Limited, for making incandescent lamps, and, I presume, for working the patents which you had taken out?—Yes.

You have already told me that in the year 1882 an action was brought by the Edison Company against the Swan Company. Did not you on July 27th, 1882, swear an affidavit in that action for the purposes of that motion?—Yes, I have it before me now.

You said that you were a director of the Swan United Company which was formed "for the purpose *inter alia* of acquiring and working my patents of inventions and certain incandescent electric lamps now known as the 'Swan lamps.' For many years past I have devoted a great deal of attention to the question of electric lighting and particularly to the production of an incandescent lamp. My experiments on this subject extend back as far as the year 1850, and I am familiar with the various inventions relating to incandescent electric lighting that have from time to time been made from that date down to the present time, and particularly the invention included in letters patent granted to Thomas Alva Edison on November 18th, 1879, referred to in the notice of motion in this action. I deny that my lamps now being manufactured and sold by the above-named defendant company are manufactured according to or in the manner described in the specification of the said last mentioned letters patent. In particular I say that in the manufacture of the defendant company's lamp the filament of carbon is not made or secured to metallic wires as in the said specification is set forth, nor is a coiled carbon filament or strip arranged as therein set forth; nor are the platinum contact wires secured to the carbon filament as therein set forth, but the said lamps are manufactured in an entirely different manner, I further say that the defendants are advised and I believe that the said letters patent of the said Thomas Alva Edison are void, not only by reason of that prior publication of the invention claimed, but also on account of insufficient description." I assume, of course, when you said "I believe they are void on those grounds" that you did believe it?—Yes, I believed it.

Now what was the prior publication to which you refer there?—It was the exhibition of the F. J. B. 1 lamp.

In what respect did you consider that the specification was insufficient?—That was a general statement that there was insufficiency of description. I was advised that the patent was defective on that point. I made that statement on the strength of what was represented to me by my solicitors.

But was there any person in the world who was better able to judge whether the directions were sufficient to enable a lamp to be made than yourself?—I am not able to say that. I was able to make a lamp, but I cannot answer your question fully.

Was there anybody who had more experience in making incandescent lamps than you had?—Possibly not; but I never made any in the manner described in this specification.

Was there any person whose information or advice as to the sufficiency of the directions to make a lamp would be more valuable at that date than yours?—It really involved legal questions—questions of construction, and what was and was not the validity of the claim—and I was depending upon the advice of my solicitors as to that.

When you made what you fairly and rightly told me was a general statement of this kind, I presume you had some particular points in your mind in which you considered the description insufficient?—Yes. I had a doubt in my mind as to the feasibility of the manner in which Edison directs the filament to be made—the tar filament. I had never attempted to make a filament in that way, but looking at the matter as an outsider, it seemed to me——

Mr. Swan! Do you call yourself an outsider?—It seemed to me that it was unlikely that a good filament could be made in that manner. I do not think so now. I meant an outsider as regards this particular specification and method of manufacture.

I think we had not the advantage of seeing you at the last trial in the place where you are now?—If it is an advantage, you had not.

Mr. JUSTICE KAY: You were not a witness at the last trial?—No, my lord.

Nor, I suppose, was Mr. Edison?—No, my lord.

The ATTORNEY-GENERAL: Mr. Edison is never in England.

Sir HORACE DAVEY: There is such a thing as a commission. By the way, Mr. Edison is alive, is he not?—I believe so. I think we should have heard of his death if he were dead.

Have you paid a visit to the United States?—No, I have never been in the United States.

On December 2nd, 1880, you took out a patent, No. 5,014, the first claim of which was for "forming the carbon or carbons of an electric lamp from cotton thread converted by the action of sulphuric acid, and carbonised by subjecting it to heat in a vessel or receptacle containing powdered carbon or other powder which will prevent the oxidation of the material under treatment." I presume that what you described in this specification was the result of experience and experiment or thought on your part?—Yes.

The only novelty in the part I have read to you was, was it not, in taking the prepared cotton thread and placing it in a crucible containing carbon—such, for example, as charcoal or other suitable powder which will prevent oxidation, and in closing the same, and then subjecting it to high heat? Did you at that time consider that to be a novel process or discovery on your part?—I thought that it was a good way of carbonising. I thought it was new, but I do not think I made a specific claim for it. I thought that whole combination was new.

The only addition in this patent is adding carbonising to parchmentising?—Yes; that was the method I had used for 20 years in carbonising.

Is it not rather remarkable, then, that you should have taken a patent out on December 2nd, 1880, describing that specially?—

You spoke in your examination-in-chief of the thread lamp. As I understand, you mean a lamp made of thread?—I think, probably, wherever I used the word thread I meant parchmentised thread.

But a lamp made with a strip of paper carbonised has a thread-like appearance, has it not, although it is flat?—In one direction.

Re-examined by the ATTORNEY-GENERAL:—In the last trial I was subpœnaed by Messrs. Woodhouse and Rawson, and in this trial by the defendants, the representatives of the Brush Company.

You have been asked why you did not communicate to me or somebody who represented the plaintiff, some information about

the Carré carbon in that lamp. Were you in communication with Messrs. Ashurst and Morris at all at the last trial?—No, I was kept very much out of the circle of consultation.

Let me understand your position with regard to this previous litigation. Did the Swan United Company possess the Swan patents?—Yes.

And all your improvements whatever they were worth?—Yes.

And the Edison Company possessed the Edison patents?—Yes.

The Edison Company urged that the 1879 patents were the master patents that covered the combination?—Yes, they made that statement.

If your company could not succeed in breaking down the Edison patent, you would have had your own improvements to fall back upon?—Yes.

In your affidavit, where you say that in the manufacture of your lamps the filament of carbon is not secured to metallic wires as in Edison's specification, what did you refer to—the carbonisable plastic material?—The connection by means of the tar and carbon paste.

You have been asked about the publication. If F. J. B. 1 is an anticipation, there is no doubt about the publication?—None.

Looking to the whole range of knowledge, do you know anything nearer Edison's description than F. J. B. 1 published before that time?—No. That was put into the hands of our solicitors before the amalgamation as the thing most nearly resembling the Edison lamp.

Do you know, one way or the other, whether at the last trial it was admitted that if F. J. B. 1 was an anticipation, Edison's patent was invalid?—Yes, I know that.

You were asked about an answer of Sir Frederick Bramwell's, in which he spoke of a rod of carbon which must have been thinned down, that in F. J. B. 1. Is it a fact that you had tried rubbing carbons down with emery paper?—I think I had thinned Carré carbons down. I certainly had thinned down blacklead filaments. I cannot answer quite positively as to the Carré carbon.

Do you remember what was said by Sir Frederick Bramwell and the other witnesses at the last trial as to what they thought the conductor was made of?—I believe they thought it was made of gas carbon thinned or rubbed down.

You remember the letter from Mr. Stearn, dated Rock Ferry, December 14th, 1878, in which he says: "I have had a lamp constructed out of a single rod of carbon thinned down in the middle. It has not yet been finished. I do not think that there can be any rupture in this one." Do you remember how the question of thinning down in the middle came about?—I did not do that; that was done by Mr. Stearn's assistant.

Do you remember how it came about that you talked to Mr. Stearn about it?—I think it probably arose from my sending some of these ground pencils that I had thinned down to Mr. Stearn, and his finding that that form of carbon did not do, that his assistant then made a similar attempt with the Carré carbon.

The Court then adjourned.

(To be continued.)

NOTES ON ELECTRICAL AMERICA.

By J. SWINBURNE and R. P. SELLON.

(*Continued from page* 538.)

THE Brush Company's works at Cleveland is as busy as ever. The type of machine has not been altered to any extent. The built up wrought iron armatures are, of course, used. Instead of German silver, aluminium bronze is now used for the hubs, as it is very much tougher and is considerably cheaper. The Brush people are also making secondary batteries, but not to any very great extent. These are made under Mr. Brush's patents. He seems to have abandoned the use of artificially applied coatings, and to have gone back to the Planté method of formation. It is interesting to note that many of those who have had much experience are coming to the same conclusion as Mr. Brush. For instance, the Crompton-Howell cell in this country is an improved Planté, and not a Faure. Mr. Brush's batteries are not like those in use in this country in one respect. He does not put a large number of very thin plates into each cell. He uses a few large cast plates, many of which have enormous surface. The plates are made by casting lead into things like large curry-combs, that is to say, they are cast all over little ridges. They are then formed. Mr. Brush has done a great deal of work on the subject of formation of plates; his English patent of 1882 is quite a treatise on the subject. In the States batteries do not find the same favour as here. In England the opinion is generally held that a central station cannot be safely run without storage batteries; in America most of the stations are run by alternating currents, and even in the case of direct current distribution they do not use secondary batteries, and they do not seem to find any necessity for them. We never saw nor heard of any station with accumulators, though American engineers have had much more experience of station lighting than we have. Though they do not use batteries, it does not follow that batteries are wrong. There may be other reasons for the difference of opinion or of practice. Batteries have not, so far as we know, reached the perfection there that they have in this country. Then again, all their high tension distribution is done with alternating currents, which precludes the use of accumulators. The direct current distribution we saw was done by Edison companies, and Mr. Edison was, until quite recently, notoriously opposed to secondary batteries, perhaps because he cannot make any claim to have invented them himself. Accumulators are used for tramcars, and are gradually coming into more general use for such purposes; but there seems no chance of their adoption for station work.

The Swan lamp patents for the States are owned by the Brush people. They have moved the works from Boston to Cleveland, and they turn out about 4,000 lamps a week. They use bulbs of the peculiar shape, blown at the pot. They have given up the use of the Swan double loop, and make a long hair-pin. The lamps are beautifully finished. We had no opportunity of seeing the manufacture. It is quite probable that they have worked out some new processes unknown to English lamp makers. All American lamps are sent out with caps. We English are very much behind in this matter. Lamps hanging by loops of thin platinum wire are unknown in the States. In most cases the lampholders contain switches, the holder and switch being strong, small, and neat. It is in details like these that the Americans show to the best advantage.

We saw many arc light stations, but they do not demand any particular description. The Babcock and Wilcox boilers are very extensively used in electric light work. Not only do these seem to be economical, but they have the advantage of getting up steam very quickly. The writer has used a Babcock and Wilcox boiler with a Jarvis setting. Steam could be got up in 20 minutes, starting all cold. The Jarvis setting is a regenerating system. Air circulates through heated passages in the walls of the furnace, and enters above the fire, thus ensuring complete combustion. Any carbon monoxide formed is thus burnt, so that the full heating effect of the fuel is utilised.

For driving arc light dynamos, where the load all comes on at the same time, slow speed engines of the Corliss type are generally used. Many of these engines are run at very high piston speeds. Not only do the Americans run their engines fast, and also their dynamos in many cases, but they use light shafting for transmitting power. For instance, in one installation we noticed a 6 inch countershaft transmitting 600 H.P. at 146 revs. This took the whole power from a large horizontal engine and carried it through a wall to the dynamo room. The chief difference between English and American practice is to be found outside the station. The machinery is all very well made in the first place, and it is well managed and well looked after in the station, but the outside installation work is very terrible.

To begin with, overhead wires are generally used. These are strung on rough wooden posts, which are often very crowded, and are stuck into the ground at all sorts of angles. The wire used for such purposes as arc light circuits is generally partially covered with a white envelope, which, we understood, is known as underwriters' insulation.

This hangs down in rags and shreds. These unsightly arrangements would never be tolerated in this country. The town authorities in the States are said to be very corrupt, and probably they concern themselves very little as to the public interests of their towns. We asked the manager of one station whether the city officials were not very corrupt. He said, "Yes, indeed." "But that is a very serious matter?" "Yes, it is quite serious," "But doesn't it throw great difficulties in the

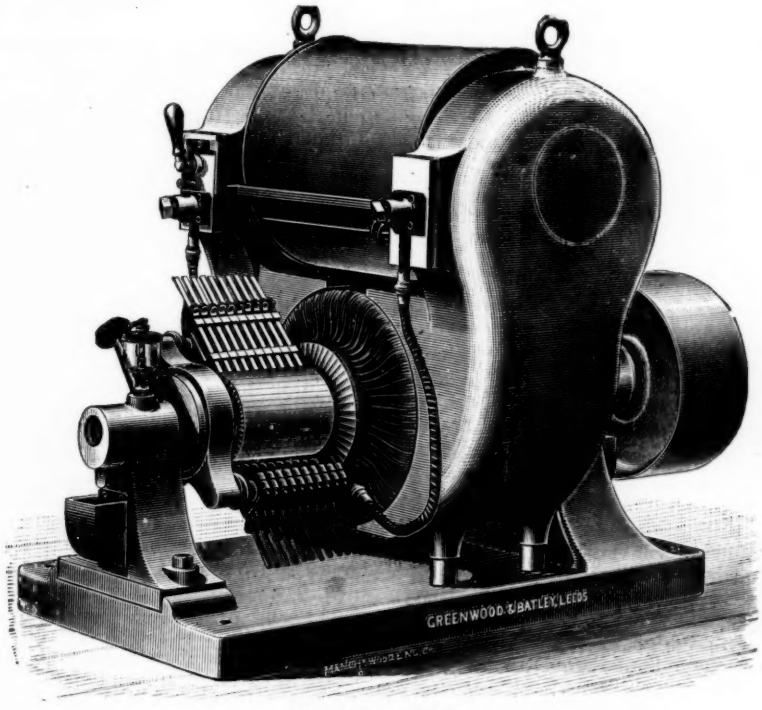
way of your progress?" "No, we find it the greatest convenience."

The laxity of the town authorities may be one reason why there is so much mud in the streets of many American towns.

Of course, we are too apt to judge such things with purely English prejudices, and to forget that labour of the sort needed to clean streets is expensive in the States. In many new towns nothing is done to the streets proper. They are not even macadamised. A wooden side-walk is made, but the main street is allowed to get thicker and thicker with mud. The Americans like mud; their traps have no mud splashers. Once driving we asked what on earth the stuff showering down on us was. "It is nothing; only what is thrown up by the wheels." This mud has led us to form a theory as to the reason why overhead wires are used so much. The underwriters' insulation would be no protection against mud. Its permeability is far too great. We believe the only merit the underwriters' insulation possesses is that it is fireproof, and that does not come in in this case. The wires then could not be laid in the mud. We can easily imagine that attempts were made to dig trenches going below the level of the mud. Such a scheme would inevitably fail; no trench could ever get to the bottom of the mud we saw, even if it were deep enough for the fireproofing to come in. It is probable that in despair they raised the wire on posts to get it away from the mud. In some towns arc lights are hoisted on poles some hundreds of feet high; this is no doubt a frantic effort to get clear of the mud.

In the houses and "stores" the lamps are often put up in the most rough and tumble fashion. A handsome and well furnished store corresponding to some of our Regent Street shops, will have its lamps dangling on irregular spirals of thick insulated wire. We have no objection to corkscrews; we can even put up with an irregular corkscrew, but a left-handed corkscrew is not to be tolerated for a moment. There is also a most reprehensible habit of hanging arc lamps on high tension circuits so low down as to be within easy reach of any idler. Even here we make the frames of the lamps part of the circuit, which is incurring danger for the sake of a very small saving in the cost of manufacture, but our lamps are dangerous to the trimmers only, and not to the public also. The Thomson-Houston works at Lynn, near Boston, are as busy as they can be. They make Thomson-Houston arc light machines and arc lamps chiefly, but they also make large numbers of alternating current machines and transformers, as they have the monopoly of the transformer distribution for some States. They make direct current incandescent machines on the same principle as the arc lighter. This machine is compounded with only one wire on the field magnets. The fields are excited as a shunt machine and a series or main is wound round the armature. It is wound obliquely so as to oppose the cross nduction and neutralise the back induction at the same time. They also make self-exciting alternate machines, and have made experiments on alternate motors, a subject to which Prof. Thomson and Mr. Rice have given much attention. The incandescent lamps made by the Thomson-Houston Company are made under the Sawyer-Man patents, and the material used for the filament differs from that employed by the Westinghouse Company and by the Swan Company. The method of attachment by local short-circuiting is in common use in America. Every Englishman who has discovered America and written on it, has told us of the extraordinary kindness and hospitality shown by the inhabitants of the States. Prof. Thomson practically sacrificed his whole day to us and showed us the whole of the works, including the lamp department. Now we must acknowledge with shame that we are not so free on this side. We had similar experience throughout our stay. On arrival Mr. Johnson, and Messrs. Martin and Wetzler, of the *Electrical World*, took us in hand, and gave us introductions to every one we might come across in our wanderings. We had the free run of all the works and central stations we could possibly visit. We ended by dining at the Electrical Club under the auspices of the New York *Electrical Review*, and felt as if we were at a meeting of the "Dynamicables."

(*To be continued.*)



THE LEEDS DYNAMO.

THE "LEEDS" DYNAMO.

THE above-named dynamo, which we now illustrate, has been extensively used for incandescent electric lighting, and the success attending its adoption in

various installations of some magnitude points it out as a machine which, we hope, will come into more extended and general use when its various excellent qualities are better known. The "Leeds" dynamo is exclusively manufactured by Messrs. Greenwood and Batley, of the Albion Works, Leeds, and as a machine for incandescent electric lighting, charging secondary batteries, for the electric-deposition of metals, or as a source for generating powerful currents of electricity, the makers claim that as a result of the simplicity of its design and excellence of its construction, great efficiency is obtained, with ease and constancy in running, facts which practical experience justifies them in stating.

The dynamo has a field-magnet of the single horse-shoe type, the core of which, placed between the pole-pieces, forms at the same time the yoke of the magnet. The core is of specially-prepared wrought iron of the best and softest quality, carefully annealed; the massive soft cast iron pole-pieces are of a form and proportions which have been found in practice to give great uniformity in the magnetic field, and the magnetic circuit is made as short as possible. The armature is of the cylinder type, with Gramme connections, and is wound with one layer only of carefully insulated wire, and the core is built up of thin annealed charcoal iron discs, insulated from each other, and firmly mounted on the shaft. The armature has a large cooling surface and perfect internal ventilation, and the armature shaft, of Bessemer steel, revolves in long bearings of "Babbitt metal," provided with sight-feed lubricators.

The commutator is of special metal of great durability, and the segments (into the one end of each of which the armature wire connections are securely soldered) are well insulated with mica plates; being of large diameter and great length, the commutator provides a maximum of wearing surface.

The brushes are small in size but large in number, and are constructed in such a manner as to be self-lubricating. The brush-holders are easily removable, and they are provided with an arrangement for maintaining an even pressure of the brushes on the commutator, and also with catches for keeping the brushes out of contact when not in use. The brush-holders are attached to a "rocker," which is free to move in either direction, backwards or forwards, according to the lead required, and which can be readily locked in any position.

The electrical connections outside the machine, as may be seen, are simple and convenient, and the large size of machines are provided with main switches and safety plugs mounted in slate boxes when required. All the materials employed are of the best quality, and the workmanship is of that high class for which the firm of Messrs. Greenwood and Batley are so well known.

The "Leeds" dynamo is of the 18-unit type, and at an approximate speed of 750 revolutions per minute will give a current of 180 ampères at an E.M.F. of 100 volts, sufficient to run an installation of 300 16-C.P. lamps.

A dynamo of this type has been working most successfully for nearly two years past at the Union Oil Mills, Rotherhithe.

These machines can be supplied as series, shunt or compound wound, according to the purpose for which they may be intended, and as a result of their being simple and compact in form, and having large wearing and bearing surfaces, they can be worked with a full load continuously without any undue heating.

Central Station Lighting.—We understand that the House-to-House Light Supply Company has ordered for its first central station at West Brompton three horizontal coupled compound engines from Messrs. John Fowler and Company, three water-tube steam boilers, with water-heaters and feed-pumps, from the Babcock and Wilcox Company, and three alternating current machines from Messrs. Elwell-Parker.

NOTES.

Electric Light at a Newspaper Office.—The proprietors of the *Scotsman* some time ago introduced to a limited extent the employment of the electric light in their establishment. They have gradually increased their installation, so that now nearly the whole of their buildings is electrically lighted. The plant consists of about 370 glow lamps of 16, 32, and 50 candle-power. The current is supplied by two 300-light dynamos, driven by an ordinary horizontal engine. There is also a storage battery of 110 cells, with a capacity of about 200 lamps.

The Dangers of the Electric Light.—We would call the attention of certain gentlemen interested in electric lighting to the paper read by Mr. W. H. Preece at the meeting of the Society of Telegraph-Engineers and Electricians, on May 10th. The points we would more particularly refer to are Mr. Preece's remarks upon the insulation of conductors, and on the practice of burying the wires in cement or encasing them in wood. As was to be expected, the author strongly condemned the idea that soldered joints are unnecessary, pointing out the dangers arising from defective joints.

Electric Lighting in Birmingham.—We understand that there is now on foot a project for applying electric lighting to a limited but important area in Birmingham. Some time ago the committee of the Old Library, in Union Street, came to the conclusion that, for the comfort of the readers, and the preservation of the books, it would be desirable to substitute electric lighting for gas lighting, provided that favourable conditions could be arranged. They consulted Messrs. Chamberlain and Hookham on the subject—the electric lighting established by that firm in part of the Art Gallery being very satisfactory—and it was found to be perfectly easy to light the library, as desired; but a difficulty occurred as to the provision of the motive power for the production of the light, the committee regarding it as impossible to make room for an engine in any part of the library premises. This difficulty, however, can be overcome by making such provision elsewhere; but in order to justify that expenditure it is necessary that a considerable area should be lighted, on conditions which would ensure to the promoters of the enterprise a sufficient number of lights, and an undertaking for permanent use of them. Having had enquiries from other persons in the neighbourhood of the library, Messrs. Chamberlain and Hookham have marked out a district bounded by High Street, New Street, and Corporation Street, up to Union Street; and have ascertained that from a common centre any buildings in this area can be conveniently lighted by electricity, provided, of course, that persons using the light are willing to give permission for the necessary connection from house to house. They are now, we understand, taking means to learn how far the tenants of buildings within this area, which includes the library, are disposed to avail themselves of the advantages of such a scheme. Their proposal is to supply the electric light by meter, on conditions similar to those which are said to be in operation in Liverpool, where a scheme of private lighting, approved by the Town Council and the Board of Trade, is now successfully working, on terms which allow the light to be supplied at from three farthings to one farthing per lamp per hour, according to the number of hours of consumption.

Library Lighting.—The Oldham Free Library and Art Gallery has been lighted by electricity since the end of January. The dynamo is placed in the gas works 150 yards away, and an insulated cable is carried overhead. The dynamo is driven by an old horizontal engine, which in the daytime does duty for the ordinary requirements of the gas works, and has been in regular work for the last 24 years. The dynamo was made, and the whole installation has been carried out by Messrs. S. Charlesworth & Co., of Oldham.

The Bournemouth Electric Lighting Company, Limited.—The first general meeting of the shareholders of this company took place last week, under the presidency of Dr. Nunn, when the report of the directors and the financial statement were formally adopted, and the following directors were appointed :—Major-General Hutchinson, Captain Williams, R.N., and Messrs. D. M. Fox, A. H. Sanderson, J. Donkin, G. J. Piercy, and Dr. W. A. Smith. Mr. H. T. Trevanion (Messrs. Trevanion, Curtis and Ridley), was appointed solicitor to the company ; Messrs. Wheatley and Cridland were re-elected auditors, vice Mr. Atkinson ; Mr. W. E. Shakell was re-elected secretary ; and Mr. Shepherd was appointed manager of the works. A vote of thanks to the chairman concluded the proceedings. Considerable progress has been made with the work of laying down the plant, and it is expected that installations will be established within a month from the present date.

The Electric Light at Leamington.—At the meeting of the Leamington Town Council, reported by us last week, there was some misunderstanding as to the way in which the Mayor recorded his vote. It appears that he declined to give his casting vote. The voting, therefore, was equal, ten for giving notice to the company to dispense with the light, and ten against it.

We are glad to learn that the Midland Electric Light and Power Company has definitely decided to introduce further improvements into its system of lighting the town. The firm is now engaged in the erection of a large installation of storage batteries, through which they will supply their customers. This will prevent the town being thrown into darkness in case of accident at the works. It is the intention of Messrs. Chamberlain and Hookham to supply the current during the whole of the twenty-four hours to consumers.

Bath and the Electric Light.—At a meeting of the Bath Town Council on Tuesday last week, the recently-appointed Electric Lighting Committee brought up its report, and the chairman (Mr. Sturges) moved that the council instruct the committee to obtain tenders for lighting a central area by electricity. He said he had ascertained from Mr. Massingham that the probable cost would be half as much again as they were at present paying for gas lighting. Several of the leading citizens were willing, if necessary, to form a local company for supplying the light at the lowest cost of production. Mr. Cox moved as an amendment to add to the resolution the following clause :—"And that the committee invite the Gas Company to tender for supplying a better light than they did at present." Alderman Clark seconded. Several members thought that if the Gas Company would supply gas of 30 candle-power it would be as great an advantage to the citizens as the introduction of the electric light. On the amendment being put only six voted for it. The resolution to advertise for tenders for electric lighting was then put and carried unanimously.

The Telephone in Madrid.—We learn that the subscribers to the Madrid Telephone Exchange number 2,500, and as applications for telephonic communication still come in, the company has been obliged to increase its capital.

The Telephone in Manchester.—The Lancashire and Cheshire Telephonic Exchange Company announces that with the object of materially improving the telephone service in Manchester, it has recently expended several thousand pounds in concentrating into the Manchester Royal Exchange all the telephone wires formerly dispersed over three separate switch-rooms in different parts of the city. New switch-boards, embodying the latest improvements, have also been erected. In order to bring these switch-boards into operation, it has been necessary to suspend the telephone service in Manchester and district for several days.

The Telegraph in the Navy.—The Engine Room Telegraph Committee, which has been sitting at Portsmouth for more than a year, has now prepared its report. As a consequence of experiments and deliberations it has been determined to fit the whole of the ships of the Admiral class with electric, in addition to the usual mechanical, telegraphs for communicating between the bridge and the engine room. As the ventilation of the dynamo flats in these ships is so bad that it is well nigh impossible for the men to live in them for any length of time, it has also been resolved to provide them with peace fittings in the shape of additional dynamos. These will be placed on the main deck and will be of 100 ampère-power. In time of war the service dynamos, which are below the water line and are protected from shot, will be used for the search lights and glow lamps. Another innovation is to be introduced whereby four projectors will be fixed in each of the Nordenfelt projections at the corners of the superstructure deck, so that in case of an expected torpedo attack the ships will be able to surround themselves with radial beams of light.

Demagnetising Watches.—Mr. Hayter, of Blandford, informs us that he is fitting up apparatus for this purpose, and that in the course of a fortnight or so he hopes to be in a position to effect complete cures.

American Institute of Electrical Engineers.—The annual meeting of this institute was held in New York on May 15th and 16th, when the following papers were down to be read :—"Some Old and New Applications of Alternating Currents," by Lieut. F. Jarvis Patten, U.S.A. ; "On Compensated Resistance Standards" and "On Prof. Moler's 'Swinging Arm' Galvanometer," by Prof. Edward L. Nichols, of Cornell University ; "Subterranean Electrical Systems," by Prof. George W. Plympton ; "The Possibilities and Limitations of Chemical Generators of Electricity," by Francis B. Crocker ; "On a New System of Alternate Current Motors and Transformers," by Mr. Nikola Tesla ; and "The Protection of the Human Body from Dangerous Currents," by Mr. P. B. Delany.

The Society of Telegraph-Engineers and Electricians.—An extraordinary general meeting will be held on Thursday, May 31st, when a paper will be read "On the Influence Machine from 1788 to 1888," by Prof. Silvanus P. Thompson, B.A., member.

Fatal Thunderstorms.—Glasgow late on Saturday afternoon was visited by the severest storm of thunder, accompanied by lightning and rain, which has been experienced for many years. About 5 o'clock in the afternoon three schoolboys were crossing Glasgow Green when two of them were struck down by lightning. A regiment happened to be at drill close by, and two of the regimental ambulance corps ran forward and found both boys dead. About the same time two boys reported at Govan Police Station that two men were lying at the half-way house on the road to Paisley. An ambulance waggon was speedily despatched. One of the men was quite dead, while the other was lying insensible. At Closeburn, about 12 miles from Dumfries, a man who was driving a pair of horses in a field was struck by lightning and instantly killed. The horses were also killed.

Alternating Currents.—Mr. George Cutter, reading a paper before the Chicago Electric Club, compared the various systems of supply by direct currents, continuous current transformers, storage batteries, &c., and his conclusions were that none of them presented all the advantages of the alternating method, whether for lighting, power, or other applications of the current already known, or which may be developed in the future.

Personal.—The Queen has been graciously pleased to promote Sir Daniel Cooper, Bart., K.C.M.G., to be an Ordinary Member of the First Class, or Knights Grand Cross of the Most Distinguished Order of St. Michael and St. George.

Legal.—The Telephone Company of Ireland, Limited, appellants; M'Cann & Co., respondents.—This was an appeal from a judgment pronounced by the Recorder at the last January Sessions dismissing the plaintiff's civil bill for the sum of £1, being one month's rent for the use and hire of a telephone, the plaintiff's property, ending November 1st, 1887. The respondents alleged the telephone was for a month out of repair, and thereby totally useless, and they claimed to be allowed credit for that month. On the hearing at the court below the company's electrician and the defendants were examined, and voluminous correspondence between the parties was read. Mr. Justice Andrews, after hearing the evidence, upheld the decision of the Recorder, and dismissed the appeal with costs.

High Resistance Arc Light Carbons.—A correspondent of the *Electrical World*, having run a double arc lamp until one of the sets of carbons was burned out, the lamp failed to strike the arc with the other carbons; the new set of carbons were continuously separated and brought together again by the action of the lamp. Being curious to find out the cause of this action, the works were closely examined, but nothing was found to be wrong at that point; when accidentally touching the carbons during this operation, the correspondent had his fingers scorched. This showed an abnormal development of heat in the carbons, which, by the way, were plain uncoppered. The reason for the non-action of the lamp and the heating of the carbons now became apparent, and upon taking them out and measuring their resistance, it was found that the 12-inch $\frac{7}{16}$th carbon had no less a resistance than $4\frac{1}{2}$ ohms. The lower negative carbon, $5\frac{1}{2}$ inches long, had a resistance of $2\frac{9}{10}$th ohms. These carbons together presented as much resistance in the circuit as would two ordinary arc lamps, including the resistance of the arcs and regulating coils.

Electric Traction in Germany.—An electric tramway locomotive has been built by the Schwartzkopf Company of Berlin town. It can exert a maximum tractive force of 8 cwt., which is sufficient to haul on the Berlin lines three ordinary tramcars fully loaded, but without seats on the roof, or two tramcars with seats on the roof. The total weight of the locomotive when in service is $6\frac{1}{2}$ tons. The current is supplied by a battery of 60 storage cells having a capacity of 320 ampère hours, and weighing 2 tons 4 cwt. The motor is a disc dynamo, with double winding on the armature and two commutators. The windings can be put either in parallel or in series, so as to vary the speed and power.

Electric Railways in America.—The *Electrical World* in the last issue which has reached us says:—"No one can read the many items this week in our department of 'Applications of Power' without perceiving that electric railways are to the fore as attractive enterprises. The increase in the number of electric railways this year extends all over the country."

Koerber's Hot-Air Motor.—Mr. Koerber has very kindly shown us one of his engines for dental purposes, to which we referred in our last issue. Upon connecting the motor to a gas jet by means of an India-rubber tube, and igniting the gas, the little engine spins along most merrily; it can be stopped absolutely instantaneously, or the speed can be regulated as desired. We were much pleased with its performance, and cannot imagine anything more simple.

Dividends from Electric Lighting.—Several of the country newspapers devote leaderettes to commenting upon the three per cent. dividend just recommended by the directors of the Hastings Electric Light Company. There is nothing like statistics to base one's opinion upon, and the local press naturally looks forward to a considerable development of electric lighting in important county towns.

Fatal Accidents from Electricity.—There have been several serious accidents and fatalities in America within the past few weeks due to an overdose of electric current. Ameron Kratz, a lamp trimmer, was permanently disabled by a shock received while in the performances of his duties on a high tower at Detroit. It is alleged that he received the shock from a wire which he had been told was "dead." He brought suit against the local electric light company for $25,000 damages. The jury awarded him $10,000. The company pleaded Kratz's negligence in their defence.

A young clerk in New York reached up and took hold of an arc lamp; he received a severe shock, and death resulted. This will give our daily contemporaries another opportunity, says the New York *Electrical Review*, to discuss and exaggerate the dangers of electricity. Had the man placed his hand on an active buzz-saw, or laid down in front of a moving locomotive and had his life crushed out, it would have been called carelessness or suicide. It is a very difficult thing to provide complete protection for that class to which the above careless individual belonged.

James Roberts, of the St. Paul Gas Light Company, was recently killed by an electric shock. He went up a pole at the corner of Jackson and Seventh Streets to operate a "jumper," to turn on an electric light at Jackson Street rink, three blocks away. Taking hold of the wire with a pair of insulated pincers, he started to make the switch, but his foot slipped and he dropped the pincers and grasped the wire with both hands. He was paralysed by the shock, fell back into the mesh of wires and hung feet downward for several minutes. He was taken down as soon as possible, but life was extinct.

A New Alternating Current Dynamo.—Mr. Mordey has invented an alternating current dynamo which is being brought out by the Anglo-American Brush Corporation. At a speed of 650 revolutions per minute it gives an output of about 40,000 watts with a terminal potential difference of 2,000 volts. The armature is stationary, and consists of a number of coils of narrow copper ribbon wound on non-conducting cores. Eddy currents are almost entirely eliminated. The field magnet is of novel design, and quite unlike anything already familiar to engineers, and it revolves with the shaft upon which it is mounted. A feature in the design of the machine, and one in which it differs from the usual arrangement, is that the magnetic leakage between adjacent poles on each side is absolutely *nil*, owing to the fact that it has poles of one sign only on each side of the armature. We understand that the machine, which we hope to illustrate and fully describe in our next, was built directly from the first design without recourse to any preliminary experiment. We regret that Mr. Mordey's description and drawings reached us too late to enable us to produce them this week.

A New Departure in Electric Lighting.—Mr. George Offor writes with regard to this subject:—"Mr. Albert's suggestion to Mr. Thornton in January, 1887, was very ancient history; the system he appears to claim as his original idea having been publicly inaugurated at Colchester on 11th June, 1884. I do not claim more than the practical carrying out—as manager of the South-Eastern Brush Company—of the plan of lighting from accumulators placed throughout the districts to be lighted and charged with a high tension current from a central station. This 'new departure' was an idea published by Sir William Thomson in 1882, and ably worked out at Colchester, as the B.T.K. system, by Mr. Frank King, the present engineer of the Electrical Power Storage Company."

Dynamo Pulleys and Belts.—In the last issue of the *Mechanical World* some papers on "dynamo pulleys and belts" come to a conclusion. These are worth perusing by young engineers who may find themselves in the responsible position of designing and fitting up a central station, and we commend them accordingly.

A New Depolarising Liquid.—We hope to give some particulars in our next issue respecting a new depolarising liquid now under test. From results which we have already obtained, it apppears that primary batteries of a certain type can be made very much more constant than hitherto, but at what cost we cannot at present say. We may add, however, that, pending further investigations, we have formed a decidedly favourable opinion of the new depolariser.

Secondary Batteries.—A letter upon this subject, by Mr. Henry A Kent, which arrived too late for insertion this week, will appear in our next issue.

Successful Electrical Firms.—The interim dividend of 12 per cent. which Woodhouse and Rawson, Limited, have just declared has caused quite a *furore* in the newspaper world. *Truth* thinks it quite refreshing that electrical engineering can be made to pay, because, truth to tell, it has always held an opposite view.

Comparative Dangers.—The most is invariable made of accidents caused by contact with wires conveying electric currents. An impartial examination of the facts, however, would often destroy the value of the arguments raised by the opponents of electricity in this matter. An American contemporary recently pointed out that electric lighting has now been in use 10 years, and there are in that country alone 200,000 arcs alight every night, yet the deaths proved to have resulted from the use of the electric light all over the world were less than 50, while every year sees in America scores of deaths from gas accidents. Of course, says our contemporary, the arc light is a dangerous thing; no electrician denies it. But the same is true of the steam-engine, the elevator, the buzz-saw, and many other agents of modern life, and all that is asked for is the use of proper precautions in connection with them.

Paterson and Cooper's Catalogue.—Messrs. Paterson and Cooper have just issued a new illustrated catalogue giving descriptions and prices of their electrical measuring intruments, comprising the well-known Ayrton and Perry ammeters and voltmeters; current and potential indicators; electro-magnet ammeters and voltmeters; and Cardew's Universal voltmeter, which is equally suitable for direct and alternating currents.

Electrical Communication on our Coasts.—Referring to the introduction by the Earl of Onslow of a Bill to give Lloyd's power to purchase land for signal stations, Mr. Robert Bayly, writing to the *Times*, observes that it is much to be desired that such powers may not be granted without a full enquiry by a committee into the whole question of electrical communication around our coasts, which has never yet been made. He refers to the enquiries made and reported upon last year by the Board of Trade Committee, which, however, was limited to the question of connecting lightships and lighthouses with the mainland electrically. This committee recommended a suspension of further consideration of the question for 18 months, and this does not afford much hope of an early improvement in connections of this character. Mr. Bayly asserts that this committee approached the most costly end of the large question of coast connection, and points to the complete system of electrical communications round the coast possessed by Denmark as an example of what is desirable here. His lucid but brief presentation of what is being done in Denmark affords a forcible argument for the adoption of a similar system for Great Britain.

Electric Light at Rome Post Office.—The Central Telegraph Station and the hall of the Central Post Office at Rome have been fitted up with the electric light. The installation took six months to complete, and is composed of 120 Edison incandescence lamps of from 10 to 16 candles. The new light is greatly appreciated by the *employés*, who suffered severely from the heat developed by the gas.

Tunbridge Wells and the Electric Light.—To the list of towns contemplating the introduction of the electric light must now be added Tunbridge Wells, where it is proposed to follow the example of Taunton, Exeter, Hastings, and other places, and form an electric light company.

The Average American Electrician.—A little science and an infinitesimal amount of mathematics seems to frighten the average American electrician. Mr. F. B. Crocker, who recently read a paper on "A practical method of calculating and designing dynamos and motors," at the New York Electrical Society, objects to Kapp's formula because it is too complicated, and proceeds to substitute for it certain empirical rules of his own, which are simple though frequently incorrect. Mr. Crocker, speaking of the old-fashioned Siemens I armature, says: "There is no cutting of lines of force in the ordinary sense, the conductors are not really in the magnetic field at all; they first *surround the lines of force, then loose them, then surround them again in the opposite direction*, and so on." Very *loose* indeed this. But the result, of course, is the same whether we consider the conductors as cutting lines of force or the coils as enclosing them. The author finds that in an armature of the Gramme type each convolution generates from $\frac{3}{100}$ to $\frac{4}{100}$ of a volt per square inch of armature core with 1,000 reversals per minute. It may surprise Mr. Crocker to learn that this is precisely what Kapp's formula gives for the E.M.F. of the armature if the density is 15 and 20 Kapp lines per square inch of core respectively. We disagree with Mr. Crocker entirely when he substitutes ampère-feet for ampère-turns, nor can we admit as true the conclusion to which this leads him. He says a given number of ampère-feet will always produce the same magnetic effect, whether they surround a 1-inch core or a 1-foot core, provided the saturation point is not passed. This may chance so in the machines he has tested, but the truth or falsity of the statement depends on a great number of circumstances which the author does not touch upon.

Metropolitan Theatres Bill.—At a recent meeting of the Balloon Society, held at St. James's Hall, Piccadilly, an address was delivered by Mr. E. E. Marriott, of the Cyanite Fire Prevention Corporation, Chelsea, on "Fire Prevention," at the close of which the following resolution was adopted:—"This meeting is of opinion that the Metropolis Theatres Bill, introduced into Parliament by Mr. Dixon-Hartland, M.P., for the better regulation of theatres and music-halls in the metropolis, deserves support, believing that it will secure, under the control of Her Majesty's Secretary of State for the Home Department, greater safety and security for theatres and music-halls, and all places of amusement and entertainment; and that a copy of this resolution be sent to Mr. Dixon-Hartland, M.P., and a petition, signed by the chairman on behalf of the meeting, be presented to Parliament." Speeches were delivered in support of this Bill and petition to Parliament by Mr. Mandy, surveyor of the Phœnix Fire Office, and others, and Mr. Ingram, C.E., drew special attention to the report of Captain Shaw, C.B., chief of the Metropolitan Fire Brigade, which advocated strongly the use of the cyanite fireproof paint.

Music by Telephone.—On a recent Saturday evening, an entertainment was given in Borough Road, Middlesbrough, by the district manager of the Northern District Telephone Company, Limited. The company had two transmitters fixed, one on each side of the stage of the Tyne Theatre, Newcastle, where the Carl Rosa Opera Company were performing "The Bohemian Girl," connected to a direct line running to the Middlesbrough Telephone Exchange, thence to Borough Road, where nine receivers were placed round a table and connected. The company assembled heard the opera from beginning to end; not only were the words clearly rendered, but the least variation in expression was distinctly audible.

Coincidences Again.—A correspondent writes:—"Erst in Lutetia, a manager manages a certain electric lighting company, a concern which, although notorious and celebrated when bearing a less luminous appellation, was some time back 'reconstructed' and rebaptised. The manager aforesaid—let us call him Mons. Nomdours—was and is a personage more astute as a man of business than remarkable as an electrician, but, as the sequel seems to demonstrate, was a good judge of the merits of an invention, being indeed something of an inventor himself, though in a non-electrical line. Amongst his staff of electricians was to be found a sole and solitary inventor. The invention of this inventor was a dynamo—or, to speak more accurately, a dynamo armature—and M. Nomdours consented to give it a trial. The armature was constructed but never mounted or experimented on; in short, the affair was dropped by the intelligent manager. Some time after M. Nomdours leaves the company in question to become the manager of another and richer electrical concern. The most curious thing in this curious story is its epilogue—namely, the patent lately taken out for the last-mentioned company, describing a machine absolutely identical with that invented by the illused electrician of the society with the luminous cognomen. Verily, the electrical microcosm is a world of strangest stories and coincidences stranger still."

Transmission of Power.—The work at the central lighting station of Trient is steadily progressing. The power is obtained from a waterfall in the Fersina brook, situated about 2,000 yards distant from the town, and at an elevation of about 330 feet above it. The water is carried by a tunnel, 2,000 feet long, to a reservoir of 900 tons capacity, the supply being at the rate of 1,600 gallons per minute. From the reservoir iron tubes take the water to the turbines, some 2,700 feet distant. The lower portions of the tubes will have to stand a pressure of about 120 lbs. per square inch. The power available will vary from 400 to 800 H.P., according to the season. It is estimated that 240 H.P. will be required for lighting the town. For the present the charge for lighting is fixed at about 0·7d. per 16 C.P. lamp-hour. It is hoped that a sufficient increase in the number of subscribers may be obtained so as to reduce this figure. The installation is expected to be completed and in working order by November next.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electrical Power Storage Company, Limited.—The annual return of this company, made up to the 3rd inst., was filed on the 15th inst. The nominal capital is £200,000 in £1 shares. 149,450 shares have been issued, upon which the full amount has been called and paid.

Patent Electric Fire Lighter Company, Limited.—The annual return of this company, made up to May 16th, was filed on the 16th inst. 1,800 shares have been allotted, 700 of which are issued as fully paid, and upon 1,100 the full amount has been called and paid.

Dalmatia Mining and Electric Power Company, Limited.—The registered office of this company is at 3 to 5, Queen Street, Cheapside.

CITY NOTES, REPORTS, MEETINGS, &c.

The Great Northern Telegraph Company of Copenhagen.

AT the general meeting held at Copenhagen on April 28th Mr. F. Zahle presided.

The Chairman of the Company, Mr. C. F. Tietgen, in rendering an account of the working of the Company during the year of 1887, first referred to the state of the Company's property, which he said was very satifactory. During the year, the interruptions of the cables had been exceptionally rare, and therefore the costs of renewals and maintenance, as well as the expense of the repairing steamers, would be found to compare favourably with that of previous years. In general, the shareholders could congratulate themselves upon the good condition of their cables, some of which had now done service for more than 20 years. Only two of them, the short sections from Denmark to Norway, and from Finland to the island of Aland had, for different reasons other than natural decay, so to say, been gradually renewed from end to end. All the other cables promised a long existence, always provided of course that they were from time to time strengthened or renewed in the most exposed places. The revenue derived from the transmission of telegrams had somewhat recovered from the falling off in the year 1886, and figured in the accounts with an increase as compared with that year, of more than £12,000, but with regard to that increase, it would always have to be remembered that it was more apparent than real, on account of the constantly falling value of the dollar. It would also be well to remark that the receipts would have been smaller if the final arrangement with the Chinese Government had been completed, but this point would hereafter be specially referred to. As had been explained at the last general meeting, the company had in conjunction with the Eastern Extension Telegraph Company, in the month of April, 1887, opened negotiations with the Chinese Government on the subject of the company's rights and general position in China. At the outset, the Chinese Government had declared that they would not acknowledge the validity of the concession of 1881, but that they were disposed to treat with the company in respect of a new arrangement to replace it. As they had been prepared for such a declaration, they had already formulated several propositions which could form the basis of the negotiations between the Chinese administration and the agents of the two companies in China. These negociations had finally resulted in the signature on the 10th August last of a telegraph convention, which a few days later had received the approbation of H.E. The Viceroy Li Hung Chang. The convention had then been submitted to the Tsung Li Yamen, at Pekin, in order that it might be ratified by that supreme authority; but up to this day, and for reasons which were not sufficiently known to him to enable him to explain them in that room, the ratification was still in abeyance. There would have been no occasion here to refer to a convention, the ultimate fate of which was still uncertain, if it had not been for the numerous attacks made upon it in the local Chinese press; attacks, a part of which at least could only be ascribed to insufficient information on the subject. The shareholders would be aware that up till now all the telegraphic correspondence between Europe and China had been transmitted by the cable routes, either by that in the north, transiting Russia, or by that in the south transiting India. As the Chinese now desired to connect their telegraph system directly with the Russian system in Siberia, the object of the convention had mainly been to conciliate the interests of this new route with those of the existing lines. This object had principally been gained by alloting to the latter the income of all telegrams to and from the towns in China where the cables of the two companies are landed (Shanghai, Foochow, Amoy, and the British colony of Hong-kong), whereas the receipts accruing from all the other towns in China would belong to the Chinese administration. If to this be added that the representatives of the three routes had to agree in fixing the rates, and that the public would be at perfect liberty to select the route which suited them best, it would really be difficult to understand the objections which had been raised against this arrangement, and particularly so by the English press in China. Not only the cordial and powerful support which had been given to the arrangement by the Russian Legation in Peking (which also has charge of Danish interests), and of the British Legation in the same place, but also the sympathy shown by the other legations, notably that of Germany, would seem to prove that the terms of the convention might well be called a happy and impartial solution of the difficulties which had arisen. With regard to the company itself, the Chairman would only like to add that the board, much against their personal wishes, but having had outside pressure brought to bear upon them from different quarters, had at last reluctantly submitted to the force of circumstances, and had accepted the terms of the Convention in lieu of the Concession of 1881, which apparently contained real and valuable privileges. If the Convention is ratified it would cause losses to the company, both immediate and future: *immediate*—because they would at once have to relinquish their share of profit on the European messages to and from the interior of China which had hitherto been acquired; *future*—because they renounced all interest in the chances of the future traffic of the same kind, which, by degrees, as the Chinese Empire is further opened out to European progress, may be looked upon as becoming very important. But, on the other hand, they would retain the peaceable possession of the traffic to and from the cable stations, which now constituted the bulk of the traffic—and they would further in future work in harmony with the Chinese administration, and enjoy the good feeling of all authorities of the country—considerations which were of great importance to the well-doing of the company. The chairman referred to what he had already said with regard to the delay in the ratification of the Chefoo convention, and added that it was in view of a speedy final settlement of that question that the board in their balance sheet had carried a larger amount to next year than formerly, as they wanted to be prepared for the first falling off in the receipts which would then be sure to show

itself. The extension of the inland telegraph system had been followed up with rather less vigour than in former years. The two lines in Mantchuria had been finished up to the Russian frontier near Blagowestschensk and Possiette, where they now wait the junction with the Russian telegraph net. The vast line running along the river Yangtzee had advanced in the south towards the frontier of Tonquin. Further, the island of Formosa had been connected with the main land by a submarine cable from Tamsui to Foochow, and likewise a submarine cable connection had been established between the Pescadores islands and Formosa. The line between Seoul and Fusan, in Corea, had not been completed, owing to the wrecking in the Red Sea of the ship which took out the material for that line, and which material had been ordered in England. The Russian Imperial administration had continued to extend the use of the Wheatstone apparatus on the Wladiwostock line. Up till now it was worked from Petersburg to Irkutsk, but towards the end of last year a number of Danish telegraph officers were engaged by the Russian Government to proceed to Siberia in order to carry out the employment of the instrument up to the terminal in the Wladiwostock station. The company had decided to take part in this exhibition (opening on the 18th May this year), with the principal object of showing the telegraphic and electrical instruments manufactured in the company's own workshops at Copenhagen, and which have been successfully shown at previous exhibitions. The total receipts of the company during the year of 1887, including the balance brought forward from 1886, amounted to £310,802 7s.; the expenses were £64,797 17s. 3d.; which showed a net profit of £246,004 9s. 9d. The following payments have been made: 5 per cent. interest on debentures 1881 and 1883 issues, £16,750; amortisation of 150 debentures, £15,000; total £31,750 The board proposed to distribute the balance as follows: reserve and renewal fund, £55,555 11s. 1d.; pension fund of the staff, £2,777 15s. 7d.; remuneration to the board of directors, £1,500; total dividend of 7½ per cent. £112,500; balance to be carried forward, £41,921 3s. 1d. The investments during last year on account of the reserve and renewal fund amounted to £75,290 4s. 6d. The report and balance sheet were adopted, and discharge given to the board of directors. Mr. M. Melchior was elected a member of the board, and Messrs. A. Berner and S. Bille were re-elected auditors of the company.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 18th, 1888, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,405.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th May are £2,802, as compared with £2,299 in the corresponding period of 1887.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending May 18th amounted to £5,526.

PROCEEDINGS OF SOCIETIES.

The Society of Telegraph-Engineers and Electricians.

An extraordinary general meeting of this Society was held on Thursday, May 17th, Dr. J. HOPKINSON, F.R.S., Vice-President, in the chair.

The CHAIRMAN announced that with a view to improving the tone and attractiveness of the discussions upon papers the Council had decided to introduce, experimentally, a rule providing that at the end of 10 minutes the chairman should ring a bell warning the speaker that the allotted period had expired, and if after two minutes the speaker had not concluded the question should be put to the meeting; but that power was given to the chairman to extend the time under exceptional circumstances.

Mr. CROMPTON then replied to the discussion upon his paper on "Central Station Lighting—Transformers *v.* Accumulators," and said: The long discussion which has taken place upon my paper, partly in my absence, is not a very easy one to answer in brief, but I will do my best to compress my remarks by grouping them into the various heads, and by giving one answer to all such remarks that may be so grouped. I would at once make an explanation to Mr. Hammond, who seems to labour under the idea that in speaking of his installations I referred to them as being carried out purely for advertising purposes. Nothing was further from my thoughts. I spoke of them as ordinary installations carried out more for the purpose of popularising the electric light than as being specimens of what an installation of a more permanent nature ought to be, and I characterised all the overhead wire installations in the same way. I must apologise to him for the mistake I made about Eastbourne. I do not know how I got it into my head that the Eastbourne installation was overhead, unless it was that I was thinking of Brighton where I knew that a considerable portion of the wiring was overhead, as also the Grosvenor Gallery installation in London. A misunderstanding has also occurred between Prof. Forbes and myself, as he appears to think that I discussed the question of transformers *v.* accumulators for all purposes, and for all kinds of installations. I would at once explain that the object of my paper was to discuss those systems for lighting such an installation as I described in London. I therefore commenced by saying that I put overhead wiring out of court. Wherever overhead wiring can be used I have no doubt that distribution by means of alternating current transformers is a very good system to use, and probably is considerably cheaper than that by batteries. But I wished to confine the discussion to the limits I put upon it, that is, the lighting of London. Mr. Kapp commenced his remarks with a reference to my load diagram, which he said though correct was hardly a representative one for London; and that, if I had taken a district in which there was much office lighting, my valleys would have been filled up, with the consequence that instead of the 2,100 units calculated I should get the 3,600 units spoken of in his article in *Industries*. I do not admit this for one moment. London is not like New York. In London our residential districts contain very few offices, our offices are grouped together in the City with a few only at the West End. But the matter that I think is of extreme importance at the present moment is the lighting of our private houses in London, because it is there that we shall feel the full benefit of the electric light, and anything that any of us can do or say which will forward the distribution of the electric light in that direction is of the utmost value. I fully admit the force of what Sir David Salomons and others have said as to the sale of motive power; there is no doubt that it is much to be desired, as by such sale we shall get a filling up of the diagram valley which will be of the greatest advantage to the supplying company, because as the capital expenditure of the company is somewhat in proportion to the height of the peak of the diagram, and the income of the company is in proportion to the area of the diagram, it follows that the more the diagram valleys are filled up the better the company will pay. The filling up from the use of motive power is therefore a thing to be devoutly desired, and I think it will come, but it was I thought hardly a fair argument for me to use in favour of the B. T. system against the A. T. system which does admit of the supply of motive power. Every one of my arguments in favour of the B. T. system will be considerably strengthened when I have the additional income to be derived in the daytime by the use of batteries. I am sorry that in the discussion Mr. Kapp appears to have misunderstood my figures; otherwise it is difficult to follow his calculations. I have seen his figures in print, and he says that, instead of using the cable I proposed, costing £116 per 100 yards of double cable, he would use a cable covered with lead, bringing the price up to £130, and he hopes by that expenditure to save a great deal in the cost of laying. In this he will find himself quite wrong. He seems to think that 3s. per yard forward is ample to cover all the expense of laying a pair of cables under a London footway. Is he aware that the £25 I have put down for trenching and repaving per 100 yards is absolutely the figure levied by the Vestry? It is a sum that we are forced to pay, whether we like it or not, and from which we can make no deduction. For every yard of York paving that we remove we have to pay 4s.; for every yard of asphalte, 11s.; and for wood about the same as for asphalte. If we suppose there is 10 per cent. of asphalte foot paving, the 4s. is brought up to 5s., and I have taken that figure throughout, which comes to £25 per 100 yards. Further, Mr. Kapp seems to have made an astonishing omission in supposing that contractors can be found to lay cables without any profit. How can any contractor take the very considerable risks of opening the ground and guarding the trenches without providing for contingencies for which he may be mulcted? He must also have profit for the use of his money, and my figure includes provision for that. If Mr. Kapp adds these items to his figures, the total will be considerably higher than the £18 10s. he has set down per 100 yards. It is highly important that I should dwell upon that specimen of Mr. Kapp's criticism, because on the cost of laying the mains so much depends, and it is a point that has been very little understood, for the simple reason that none of us have had any experience of it until the last two years. I really thought that I was bringing before you something that would be of great use to those who are considering this subject, and who wished to have some idea of what had been the cost of such cables as have been already laid. Although I deprecated criticism upon my Table No. 2, because I did not consider that my system of laying was perfected, that Table has been severely criticised, especially by General Webber. But the edge is taken off his criticism by the fact that he misunderstood the method. He talked of the conductor being suspended from the roof of the culvert. If that were the case, no doubt water collecting in the roof would run down the suspending means, whatever they are, and a film of water would be deposited on the insulators, and no doubt thereby the insulation would be reduced. But, as a matter of fact, it is not so; the insulators stand upon short pillars from the bottom of the trench, and I see no reason to believe that the insulation would suffer in any way if there were two inches of water, or more, either running along or lying in the bottom of the trench throughout its length. I cannot conceive how it is possible for the state of things prophesied by General Webber to occur. He says that we shall get the trench gradually blocked up by *débris* left by water, that vermin of every kind will congregate in the trench, that legions of rats will be running along them, and that in a short time the culverts will be in such a condition as to entirely cause the insulation to disappear. Well, we have had one year's experience of this class of culvert, but none of those things have occurred,

neither has any sign of them appeared. We have at the same time had a very trying winter, and as may be expected from the circumstances of a new installation, the trenches have been opened a great many times oftener than they will be in the future; they have been exposed to all kinds of weather, with greater opportunities for wet to get into them than will occur again, and yet in spite of all that, the insulation of the bare cable is as high, length for length, as that of the best cable made by the best makers in the world, which I believe are those near London. On this point I would like to refer to an interesting fact which may be of some use to some of you. It is very easy to measure the insulation resistance of a cable that remains intact from end to end by megohms; but when a few hundred cuts have been made through the insulation for branches to be jointed on, it matters not how carefully the joints are made and the insulation replaced, every joint becomes a source of leakage, and the megohm comes down to a few thousand ohms. The exterior surface of the cable becomes one vast means for communicating the leaks that are started in the minute cracks of the joints to the ground, there is an enormous ground surface whenever the hemp or jute covering comes in contact with the pipes or troughs containing the cable. I speak solely from practice; we find it extremely difficult to make the joints tight, and that is the one point where the greatest difficulty will arise with the A.T. system when its advocates place the cables carrying their high potentials underground. I am perfectly aware, as stated by Mr. Fleetwood, that there are many places in which we cannot use the culvert system, but it is not necessary, as he supposes, for us to have a culvert 18 inches square; nothing of the kind; we have actually used culverts 5 inches deep—I believe only 4 inches deep in some cases—on account of the cellar arches approaching so near the surface of the pavement. We want a considerable width, because in my system I place a mid-feather of brickwork between each conductor, so as to make it impossible for any swinging or side movement of the conductors to make a short circuit. But 18 inches is ample for the 3-wire system, and I have no doubt that if I wanted to get a charging main in addition, 24 inches would be ample, and there is no difficulty in getting that width under the footway; the difficulty is in getting depth. We have not hitherto been stopped in getting sufficient width, but we have in several cases had the depth cut down to 2 inches, and then no system will do but that of an ordinary plumber's pipe, 1¼ or 2 inches in diameter, in which a good lead covered cable can be drawn. I turn now to the cost of the generating plant. Most of the actual makers of alternating current machines appear to think that I have under-estimated the cost as set down in my paper; Prof. Forbes is alone in thinking the contrary, but that may be owing to the wonderful organisation he told us of at Mr. Westinghouse's factory, where only three kinds of machines are made, and which are turned out by special machinery. I see no reason why we should not be able to imitate that in this country if we have a demand equal to that of Messrs. Westinghouse, but I do not think, if my arguments are correct, that there will be the same demand for alternating apparatus in this country as in America. As to transformers, Mr. Kapp does not say that my price is too high, but that I over-estimate their number in allowing one for each couple of houses, and he goes at once to the other extreme of putting his transformers into ten distributing stations, or, to use what Prof. Forbes tells us is the American expression, he "banks" them in those stations. I wish to point out that to distribute from those ten transformer stations will use just as much copper as I use for my ten distributing stations. He told me that my calculations were all wrong, and that the copper I allowed was only sufficient to give the fall of potential if I distributed from ten stations, and therefore he would have to adopt my figures and 2,000 yards of cable at the cost in my table for the B.T. system. By that means he will at once have an addition of £6,000 on the cost of his distributing mains, and on the top of that he will have to add the cost of the sub-feeding mains to carry the current from the charging main to the sub-stations. I have not run that figure out as I do not know how he is going to place his stations, but it will probably be £3,000 or £4,000; thus £10,000 is at once added to the cost of his system by this method of distributing. What does he gain? A few thousand pounds in the cost of transformers. If he saves half the cost I have taken for transformers it would mean that he would spend £10,000 to save £3,500. That is a specimen of the proposals made by Mr. Kapp to reduce the cost of the A.T. system. I think, however, from conversations I have had that Mr. Kapp's proposals are not generally received, and that it is pretty certain that transformers would be put in for every two houses, as I have calculated, and under those circumstances I do not see how the cost can be reduced. It is not the cost of the transformers, but that of starting a fresh job each time one is put down, as each one not put down with the original bulk will require new men to be sent out, and all of us contractors know how much more expensive is a small job than continuous work, which can be given out on contract. Those who have had experience of contracts will, I think, admit that the figure of £15 for two houses, including the cost of the transformer, and taking all risks, is excessively small, and I do not see how it can, by hook or by crook, be reduced. As to the very vexed question of the efficiency of transformers, my statement as to their efficiency at low rates of output has been traversed by several speakers. I am prepared to adopt the figures of the advocates of the alternating current transformer system, and will suppose that the efficiency is as high as they make it, but I still say that 40 per cent. of the total daily output is taken out at an extremely low rate; the diagram shows that, and it means that there are a few lamps only running in each house during about nine hours of the day. I cordially endorse Mr. Preece's observations upon the pluck shown by Messrs. Gaulard and Gibbs; nobody admires the result of their labours more than myself in pushing that system to its present success. Nothing in my paper was intended to detract from the credit that they have fairly won in the teeth of such uncompromising opposition as I am now receiving from their friends. Mr. Swinburne remarked that transformers do not regulate but "compound down," and that remark has not been noticed by the friends of the A. T. system; when the E.M.F. falls the load is increased, and no one has succeeded in winding transformers to overcome that difficulty. If that be so, and no one has denied it, it is another serious difficulty in the face of distributing by the A. T. system, and one which I did not take advantage of when comparing the merits of the two systems in my paper. Now I turn to the accumulators. I must first point out that in my paper I treated solely of the use of accumulators as transformers, a point which Mr. Drake alone has brought strongly to your notice. There is a very wide difference between accumulators worked as I have advocated, to act as transformers during the hours of large demand when the current comes direct from the dynamos, and supplying the long periods of small output, as against the plan of charging them in the daytime, so as to discharge them at night. Several gentlemen asked why I did not refer to the Colchester installation. I admit that the Colchester installation was worthy of reference, but it was so totally different from the kind of installation I have been talking about, and so utterly out of comparison as regards cost compared with the alternating current transformer system, that it is out of court. My figure for batteries would have to be multiplied by six if they were used as in the Colchester installation. We are now beginning to understand more about these batteries, and no doubt as our experience extends, we shall use them more largely than I now propose. The time may come also when I shall be able to produce a balance-sheet, in which the charging mains would be very much reduced, and in which there would be a much larger number of distributing stations with reduced distributing mains; but I have guarded myself against stating a "hypothetical case," as was wrongfully said by Professor Forbes. The whole of my figures are based upon experience; every figure that I have put down I have said over and over again I am prepared to prove by carrying out the work; I have done it before, and I can do it again. I must point out, however, that what I have done with the battery transformer system has not yet been done with the alternating current transformer system, except, as Mr. Hammond informs me, that it has been done at Eastbourne. I am glad to hear that it has been done in one case, but I hear that at Rome, where Siemens concentric cables have been put underground with great care, and every trouble to get high insulation taken, much difficulty has been experienced, and the cost of the distribution has been extremely high, simply on acccount of the perpetual taking up of the mains for repairs. I adhere to 400 volts or 450 volts as my figure for distribution, because although I should very much like to use 600 volts or 800 volts, I do not know whether difficulties will then occur which have not hitherto been met with. I have successfully distributed the Vienna installation of 13,000 lights, which is larger than the one we are talking of; the mains are nearly 1,500 yards long, which is nearly on all fours with the system spoken of, and it is not too much to say that everything put down in my tables both as to capital cost and working cost, is nothing more nor less than detail taken from the Vienna work as near as I dare state the figures, for, remember, I am the contractor for a company who would not care to have their figures published to the world. At Vienna with the 440 volts we are using we have never had any trouble. Mr. Kapp says that I should not be allowed to use it here, but I could prove to Colonel Armstrong, whom I see present, that no danger to life or limb, or from fire, exists with those four groups of batteries arranged in series which supply the 400 volts. What we have done once we can repeat; but in London an enormous amount of work can be done without the four batteries system; it can be done on the two-battery system, in fact an ordinary three-wire system, like the Edison work in America, with the advantage that the cost of the feeding mains can be cut down in proportion as you have batteries to work the extra peaks in the diagram. There is a perfect little installation at La Manche which has worked for sometime without any hitch. At the gas works there there is a generating plant, the dynamos giving about 250 volts, a pair of cables are carried to an accumulator station from whence the three-wire system is taken all over the town. Some gentlemen hardly appreciate the fact that when batteries are used the cost of feeders may be very largely reduced if the batteries are placed at the distant point, on the ordinary system, not the three-wire system; and a corresponding gain is effected when the three-wire system is used. I have shown that the gain is so great when using 440 volts that the cost of the copper involved is more than compensated for by the extra cost of the wire on the main of the A. T. system, for it will be seen from the table that in the A. T. system the main costs £6,160 and in the other system £6,137 for 2,000 yards. Beyond 2,000 yards I do not deny that there will be a considerable balance in favour of the A. T. system. But in spite of the slighting terms in which Professor Forbes spoke of a little installation of 10,000 lights, I may point out that such a system with 2,000 yards of charging main forms one-tenth of a 100,000 light installation; with 2,000 yards of charging main, 100,000 lights may be very easily distributed from a waterside site in London exactly

on the lines shown in my paper. Therefore there is nothing in Professor Forbes's point that 10,000 lights is a small unit, for, as a matter of fact, it is quite a sufficient unit to enable calculations to be made as to charges of cost and interest, though there may be some charges that are altered in the case of larger installations. In reply to Mr. Kapp I would say that the rent of an accumulator station is really included in the items shown in the paper, and if the rent of the larger station required for the machinery of an A. T. system is set against the £150 rent for three accumulator stations the result is not affected. Mews property is not let in part, and £50 is the lowest price even if only occupied by a small transformer. Mr. Parker complained that I have not described the Howell accumulator; my paper was intended to apply to all well-known accumulators and not to my own in particular; I therefore resisted the temptation that presented itself of giving a description of my own cells. But I am perfectly certain that Mr. Parker can turn out very good cells and, judging from his remarks, he is a good advocate for them. Mr. Kapp's question as to the cost of accumulators has been answered by the practical makers, for Mr. Parker, Mr. Sellon, and Mr. Drake are practically agreed as to the correctness of my figures, Many gentlemen expressed surprise that I claimed 80 per cent. efficiency for the accumulators between the lamps and the terminals of the dynamos, but I have had that efficiency for many months at Vienna with E. P. S. accumulators, and I have obtained a higher efficiency at Kensington, as well as in a private installation of my own. There are two kinds of efficiency, one the total efficiency, that is, the watts at the lamp divided by the watts at the terminals of the dynamo; the other the current efficiency, that is, the current taken out of the dynamo divided by the current put in. I am speaking of the watts efficiency, when the dynamos and batteries are working parallel and the current is neither being put in nor taken out of the accumulators, when there is little or no loss owing to the fact that the batteries are connected parallel to the circuit, which is otherwise a direct circuit. Of course if any short circuit or leakage occurred inside the batteries, from plate to plate, there would be loss, but it is perfectly easy to guard against such a thing happening if proper care is taken; it has not happened at Vienna or Kensington. In times past I know trouble has been caused by bridges of oxide forming across the plates, and in that way accumulators have got a bad name, but they are better understood now, and it pays to have sufficient staff to prevent such things occurring, for directly they begin great damage is done to the accumulators. Now, I have shown you that at the time when about 60 per cent. of the total output of the efficiency of the accumulators does not come into question it is more a question of the direct supply through the remainder of the time at about 40 per cent., and I have shown you, when speaking of transformers, that for about nine hours the discharge is at a very low rate. By actual experiment I know that 82 per cent. of efficiency can be got at that time, but I really calculate on 70 per cent. If you have 60 per cent. at no loss, and 40 per cent. at the loss I spoke of you would get a total efficiency of 87 per cent.; still I have not claimed anything of the kind, but something considerably less, therefore Prof. Forbes's criticism on that part of my paper entirely falls to the ground. As to the depreciation of batteries, Mr. Gordon has made public certain figures which show, though it was not my intention that he should read them, what we can afford in the way of maintaining batteries, and I think we are well within the mark when we say that we can maintain them for 12½ per cent. During my recent visit to Vienna I had ample opportunities for inspecting the large battery of accumulators, and I ascertained from the company that they were not willing to allow anybody to provide and maintain accumulators at 10 per cent., as they thought that it could be done for considerably less. At Kensington Court the repairs and alterations have amounted to about 2 per cent. of the cost, and I have a battery in my possession which has had heavy use but has not cost a penny for two years, and I do not see why it should cost a penny for the next two years. Mr. Drake has referred to accumulators at the P. & O. Company's offices, which have been carefully dealt with, and have lasted for four years. Mr. Kapp says that I have made an error in calculating 4 per cent. variation. If he had worked it out, as I did, carefully, he would find that it is quite a safe figure, as by putting on additional cells at the time of maximum demand it can be made not more than 2 per cent. and even 4 per cent. variation is not so terribly noticeable as Mr. Kapp thinks. Mr. Hammond said that accumulators were unnecessary because every one knew when a steam engine was going to stop. His experience must have been very favourable; my experience is that steam engines often pull up very suddenly, owing to the connecting rod getting warm or something else, just when the heaviest load is on. Belts, too, slip off. Professor Forbes made his remarks I am told in a particularly pungent tone. Had I been present I might have reduced their pungency by making a running comment, because a large portion of them were based entirely on false premises. If I refute a few of his remarks you can judge from them as to the accuracy of the whole. He objected to my use of the words "I am told," as leading you to suppose that my paper was based upon hearsay evidence and as such should not have been brought before the Society. The boot is on the other leg. I have talked from experience, Professor Forbes from what he has been told. I only used the words "I am told" when referring to statements made by the makers of accumulators other than my own, because I can answer for my own but not for those of other people. My paper contained more commercial and contractor's experience than any other paper read this year before this Society, and you will find that those who read papers on scientific subjects will deal with everything but the commercial results, which may be copied and taken advantage of by rival firms. I feel a little sore on the subject, as in my paper I have tried to put myself above that sort of thing. The figures I have put before the world are of great use to contractors, and to Professor Forbes, who does not know what the cost of laying a section of cable is; he has never laid a main, nor paid a contractor, nor checked a contractor's account. I say that because there has not been a job carried out for main laying in this country under a consulting engineer. Prof. Forbes cut away all my reserve plant, as he considered that continuous-running plant was so good that it could be dispensed with; and he gravely informs us that Mr. Westinghouse gets 600 kilowatts at the lamp out of 1,000 horse-power; that is, 80 per cent. of the indicated horse-power in the cylinder of the steam engine in effective electrical horse-power at the terminals of the lamps. Never was such a monstrous statement made. We rather fancy ourselves in this country about making engines and dynamos, and Mr. Willans has made probably the finest engines ever produced. Mr. Westinghouse has copied Mr. Willans: it is a very bad copy; and Mr. Westinghouse is supposed to have obtained with his engines and dynamos 12 per cent. higher efficiency than has been ever obtained by the Willans engine and the Edison-Hopkinson dynamo. If Prof. Forbes listened to such statements after his long residence in America, and we are to measure the remainder of his statements by that one, I say that some discounting must be done. But I do not think that he seriously believes 600 kilowatts can be got out of 1,000 horse-power, and he will have to admit that it requires about 1,200 horse-power, and 250 horse-power is a small reserve for that. The opinions in the discussion of those who are practically acquainted with central station lighting appear to be fairly balanced, but figures are worth more than opinions, and I have figures which show that in point of labour, conductors, fuel, and wear and tear, the B.T. system is overwhelmingly superior to its rival. No doubt many in this room know that I speak accurately in stating that in their future estimates the Grosvenor Gallery people will base their coal consumption on the supposition that each electrical horse-power in the lamp will take about 18 lbs. It is needless to say that I should not advocate the B.T. system before you if I thought it would take as much or even a quarter of that quantity. When my large installation at Kensington is completed, I intend to arrange that gentlemen shall, if they choose, see that the statements I have made about the B.T. system are correct. I have shown you that in the A.T. system the dynamos are more expensive, more difficult to put in parallel, and that the machinery must be always working. Against those facts you have with the B.T. system cheaper plant, and machinery that need not be always moving, involving, consequently, very much less labour than the A.T. system. No income is possible from motive power with the A.T. system, while there is the possibility of a large future income from the B.T. system. When all these facts are put together, and I can prove my statements, I think I have prepared a formidable array of charges against the A.T. system.

The adjourned discussion on Mr. PREECE's paper on "Fire Risks and Fire Risk Rules" was continued.

Mr. MUSGRAVE HEAPHY said: At the last meeting I asked and obtained permission to make a statement this evening as to the reason the sittings of your committee on the Phœnix rules were interrupted, for I felt the account given by Mr. Preece unintentionally conveyed an erroneous impression. Had it not been for that remark I should not have spoken at all, for obvious reasons. In May last a committee of our council was formed to revise their rules of 1883; communications were opened with the Phœnix on the matter, the result being that a tentative agreement was arrived at: that in order to settle once for all any difficulties as to rules for the future, the Telegraph Engineers' rules and the Phœnix rules should come out under the same cover, the cover to contain no mention of the Phœnix. The first portion of the pamphlet was to contain general rules and principles for installations, drawn up by your committee; the second portion of the pamphlet the Phœnix detail rules for installations, there being an acknowledgment clause that these detail rules were the Phœnix rules. In order to make certain that there was nothing in the Phœnix rules that would be objectionable, four gentlemen of your committee were to form a sub-committee and to go over them word for word with me, and in the event of your not agreeing the arrangement was to come to an end. These gentlemen were to be men practically acquainted with the difficulties of electric light installations. They were: Mr. Preece, Mr. Siemens, Mr. Crompton, and General Webber, and it is impossible to thank these gentlemen too much for the time and care and labour they bestowed, especially Mr. Preece, and I am sure if the matter had been in their hands I should not have been so unfortunate as to be troubling you now. We had many sittings at the offices of your society, without the slightest hitch or difficulty of any kind, and the Phœnix rules were unanimously approved after certain verbal alterations had been made, and a few other slight variations. The acknowledgment clause was then framed and agreed to. The sub-committee then revised their general rules; with these I had nothing to do. These general rules were not those they have recently issued. I thought the matter was now at an end so far as I was concerned, when I received a letter asking me to attend your committee to explain certain rules. I thought this strange, as the matter had been so thoroughly gone into by the sub-committee, and that they would be conversant with every point. I accordingly went, when, to my surprise, the first thing

I heard was the acknowledgment clause called into question, with an intimation that instead of the detail rules being acknowledged as the Phœnix rules, they should be called rules *based* on the Phœnix rules. I also found that the whole of the Phœnix rules were to be gone over again, not the original Phœnix rules but the slightly altered Phœnix rules that were in the cover of the Telegraph-Engineers. What, then, was the position of the Phœnix? Their rules might again have been slightly altered verbally, and the acknowledgment clause altered objectionably and all copyright lost, perhaps the very name of Phœnix might have been expunged in the next edition altogether. And what remedy would the Office have had? None! If it objected, the answer might have been:—"The detail rules have been drawn up with the consent of your own representative sitting as one of the committee. You cannot now refuse to recognise these rules, nor object to the acknowledgment clause, whatever it may be." The Phœnix Fire Office, after a time, might have been entirely deprived of its rules. I only say, "might." What was the only course open to the Phœnix? What would any of you have done? Why, what the Phœnix did—say that unless the acknowledgment clause was to stand as agreed upon in the event of your committee being satisfied with the rules, it must retire from all negotiation. It then wrote this letter—there is not time now to read it, but I do hope that your committee will allow it to be printed in the "Proceedings." And I attended the next meeting, when the committee declined to give me any information until the sitting on the Phœnix rules in their pamphlet had been completed. I declined to sit with them. Gentlemen, I had nothing left but to retire. Several gentlemen on the committee asked me to stop, saying I could reckon on their support; that I knew; but when I said, You may possibly be outvoted by others of a different opinion, the reply from some was "Yes, that might be so." I do not wish for one moment to impute that your committee would have done anything that it did not consider right and honourable—I do not wish to cast the slightest imputation upon any one of them—but remember, there are often two different ways of regarding the same thing, and what would seem perfectly fair and right from one view would be felt as a bitter wrong and injustice from another. Let me give you an instance: a speaker last Thursday, in this room, actually stated in effect, that because some of the clauses in the Phœnix Rules which were brought out in February, 1882, were then similar to certain rules in America, therefore there is no right to copyright in the present Phœnix Rules, notwithstanding all the original thought and labour bestowed upon them to make them perfect, and that an installation put up by them is different from that in America or any other country, and that the rules treat upon systems of lighting undreamed of six years ago. All this is to be monopolised by any one who chooses to appropriate it. I can assure you that the Phœnix has always been, and is now most willing and anxious to do everything that is just and right, but it does consider that fairness should be done to it in return. Gentlemen, you know what injustice is! you have had to feel the tyranny of Chamberlain's Act, but that Act is mercy itself with the one that is now sought to be imposed. You had 21 years before your work was confiscated; the Phœnix Rules are not to be granted any time at all before they can be appropriated. I will never believe that you will be a party to such a wrong.

Mr. HUMAN said that Mr. Preece, in referring to a clause in the Guardian rules relative to the insulation of an installation, had misunderstood the matter; he had confounded the leakage from the whole installation with the leakage from the wire only: he thought that to measure a loss of $\frac{1}{5000}$th of the current would require an exceedingly delicate instrument.

Lord CRAWFORD had urged the Committee not to multiply the rules to too great an extent, as to do so was to multiply the weaknesses. He thought what Mr. Heaphy had said with reference to the Phœnix rules was very true. He owed a debt of gratitude to the Phœnix, as he had found that the installation at the Grosvenor Gallery, which had been put up under the Phœnix rules, had been entirely satisfactory; there were 20,000 lamps in this installation, and they were adding to it at the rate of ten houses a day. He had come to the determination that any house not fitted up under the Phœnix rules would have to be before the current was turned on to it.

Mr. WHARTON considered that the Phœnix rules did not require any alteration, as no fire had occurred where their rules had been carried out; as a contractor he did not want any alteration made.

Mr. SHOOLBRED would ask Mr. Preece as to the source of danger from the heating of wire. Mr. Preece had made a large number of experiments on the subject. He thought that a considerable amount of ill-feeling had resulted from Rule 2 being overlooked. This rule stated that "the rules were not to supersede others." The matter had been put and discussed as if it were a question whether one set of rules only should be allowed to exist; this he did not think was the intention of the committee.

Mr. PRIOR could not understand Mr. Heaphy's position, as his rules were not accepted by all offices, and there must be some reason for this. Offices are not able to protect contractors, and it is not their business to do so. They were anxious to protect themselves from fire, and they had nothing more to do than to see that the general arrangements were satisfactory. He preferred rules which covered principles. If electric lighting became general the Phœnix rules would cease to be of use.

Mr. RAWLINS said it seemed singular that two members of the society were ready to throw over the society's rules and adopt those of the Phœnix office.

Mr. HAMMOND would suggest that all insurance companies should allow a reduction of, say, 15 per cent. in the premiums, in cases where electric lighting was adopted.

Mr. PREECE considered that the discussion had taken quite a different line from what might have been expected. He had hoped that numerous cases of accidents which had occurred would have been mentioned. He intended only to refer to scientific points. Some of the speakers seemed to think that the Fire Rules affected insurance offices and contractors only, but users were really those most interested, and it was the object of the rules to protect these from fraud. Contractors gave orders to manufacturers, and the latter did not follow out these orders. Although the discussion had been an animated one, he doubted if any opinions had been changed as the result of the same. A great deal of amusement had been afforded if no information had been gained. Mr. Human had referred to the difficulty of measuring a leakage of $\frac{1}{5000}$th of the current; this was equal to about $\frac{1}{5000}$th of, say, 15 ampères, and this amount could be measured with the greatest ease; indeed, any telegraphist could do it. Mr. Shoolbred had asked a question concerning his experiments on the heating of wires. This question had occupied his attention for some years, and he hoped at some future date to be able to announce that he had completed some experiments which would show the temperature which a wire would acquire when a given current was passed through it. Mr. Macfarlane and Mr. Sabine had done something in this direction, but not with entirely satisfactory results. In conclusion, he expressed his regret that the original idea of the paper had not been followed out, but he hoped that someone more competent than himself would take the question up again.

The meeting then adjourned till May 24th.

NEW PATENTS—1888.

7035. "An electrical coupling." W. E. LANGDON. May 11.

7083. "Improvements in electro-medical batteries." T. W. FORD. May 12.

7102. "Improvements in apparatus or appliances for automatically obtaining light by electricity applicable for lighting cigars, pipes, and the like purposes." C. H. BAINES. May 12.

7111. "Improvements in electrical couplings, partly applicable to other purposes." J. H. DAVIES. May 14.

7131. "Improved apparatus for measuring and regulating electric potentials and currents." Sir W. THOMSON. May 14.

7256. "An improved combined holder, switch, and cut-out for electric glow lamps." F. ROWLING. May 16.

7301. "Improved apparatus for measuring and regulating electric potentials and currents." Sir W. THOMSON. May 17.

7308. "Electric date and time printing stamp." C. A. RANDALL. May 17.

7332. "Improvements in and connected with conductors of electricity." H. EDMUNDS. May 17.

7333. "Improved electrolytes for electric batteries." R. MCKENZIE. (Communicated by H. Weymersch, France.) May 17.

7355. "An improvement in field telegraph and other similar conductors." R. VON F. TREUENFELD. May 17.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

3225. "Improvements in and relating to the generation and distribution of electric energy and machines or appliances therefor." R. DICK and R. KENNEDY. Dated March 2. 8d. The inventors use a combined dynamo-electric generator and electromotor. The motor field magnets and generator field magnets together form the carcase or framework of the machine; while the motor armature and commutator are by one arrangement fixed at one end of a longitudinal shaft mounted in bearings, and the generator armature and commutator are secured on the other end of this shaft. The claims are 3 in number.

3658. "Improvements in alternating current transformers or induction coils." R. DICK and R. KENNEDY. Dated March 10. 8d. The inventors wind the transformers with two circuits—a primary and secondary—for the alternating currents, in the usual manner, and by their improvements they use a third circuit for the circulation of an independent current flowing continuously in one direction, and this continuous current has for its object the initial magnetising of the magnetic iron organ portion of the transformer continuously in one direction. The claims are 3 in number.

4322. "Improvements in dynamo-electric machines." J. HOPKINSON and E. HOPKINSON. Dated March 22. 11d. The armature consists of a series of bobbins having iron cores composed of thin plates placed tangentially or nearly tangentially to their direction of motion. The bobbins are bound in by rings which slip over their ends. The claims are 8 in number.

4472. "Improvements in electro-deposition of cobalt." S. P. THOMPSON. Dated March 25. 6d. Claims:—1. In the process of the electro-deposition of cobalt the use of magnesium salts in the bath. 2. In the process of the electro-deposition of cobalt the combination with the salts of cobalt or of cobalt and ammonium of salts of magnesium, substantially as specified.

4781. "Improvements in electric batteries." THE ELECTRICAL POWER STORAGE COMPANY and H. W. BUTLER. Dated March 30. 6d. Claim:—In and for electric batteries a perforated or reticulated separator and distance pieces or projections, substantially as and for the purposes described.

4809. "Improvements in insulating electrical conductors." E. TORTORA. Dated March 31. 8d. The inventor places the conducting wires in short glass tubes or boxes hermetically connected together by leaving sufficient space within the glass tubes or boxes to form a layer of air around the wire. The air to be supplied to the interior of such glass boxes or tubes should be dried by passing the same through sulphuric acid, over caustic lime or other hydroscopic material or by similarly treating. Instead of dry air a non-conducting gas or gases may be employed n the glass tubes or cases. There is 1 claim.

4978. "An improved holder and switch for electric lamps." F. T. SCHMIDT. Dated April 4. 8d. The object of the invention is to construct a holder suitable for electric lamps in which are combined a switch and fuse, and to so arrange the same, that the light can be switched on or off when several lights are supplied by one cable. There is 1 claim.

4980. "Improvements in apparatus for making and breaking electrical circuits in connection with call or alarm boxes." F. T. SCHMIDT. Dated April 4. 8d. The apparatus is secured inside a box and consists of a series of wheels mounted in suitable framework, and around the axles and secured to a wheel whereon is a coiled spring, and on the said axle is secured a lever. The spring is coiled up tight somewhat like the spring of a clock, and when the before-mentioned lever is operated, the spring is coiled tighter, by which the wheels are put into operation. On one of the shafts is a disc having a number of pegs or pins inserted which project therefrom, and as the disc rotates the pegs come in contact with an arm attached to a lever forming part of the electric circuit with one of the terminals, raising the lever out of contact with the other terminal, thereby breaking the circuit as often as there are pegs in the disc, thus indicating at the central or distant station the number of breakages, by which the attendant knows the box and district from whence the alarm has been sent. There is 1 claim.

5009. "New and improved methods of charging and recharging, cleansing, changing, and varying the chemicals and liquids used in secondary batteries, or accumulators." J. T. ARMSTRONG. Dated April 4. 6d. The inventor supplies, charges, recharges, cleanses, changes, and varies the chemicals and liquids used in such secondary batteries (or accumulators) in the same manner and by similar methods, means and appliances as those described in Letters Patent, Nos. 6,878, 1885; 398, 1886; 8,573, 1886; and 10,824, 1886. There is 1 claim.

5092. "Improvements relating to switches for electrical purposes." B. EGGER. Dated April 5. 8d. Claim:—In switches for electric conductors in general, and for combined incandescent lampholders in particular, the employment of joint levers in combination with springs in such a manner that to an optionally slow or quick movement of a hand lever, slide, or any other secondary mechanical part taking this place, corresponds an extremely rapid movement of the contact lever proper, for the purpose of rapidly making and breaking contact, and the movements in both directions are accompanied by similar mechanical actions, substantially as described and represented in the drawings.

5228. "Improvements in holders for incandescent electric lamps." W. H. BAYLEY. Dated April 9. 8d. Relates to holders in which terminal plates on the lamps press against the ends of contact pins carried by the holders, and has for its object to facilitate the wiring of the holder, and to ensure a thorough contact between the terminal plates and the contact pins aforesaid, so as to avoid any risk of firing or sparking. The claims are 5 in number.

5707. "Improvements in automatic cut-outs for electric arc lamps worked in series." E. F. H. H. LAUCKERT and H. W. KINGSTON. Dated April 19. 8d. Claim:—As a cut-out for each of a series of electric arc lamps a solenoid having a coil of high resistance in a by-pass to the lamp circuit, and a core supported by a spring and arranged to act on contacts, whereby when the core is drawn down by increased attraction of the solenoid resulting from extinction of the lamp a by-pass circuit is established, including resistance equivalent to that of the lamp, substantially as described and illustrated by the drawings.

6972. "Apparatus for obtaining derived currents of variable intensity from a main electric current." J. C. MEWBURN. (Communicated from abroad by La Société Anonyme pour la Transmission de la Force par l'Electricité, of Paris.) Dated May 12. 8d. Consists of apparatus whereby a portion or fraction, variable at will, of the intensity of a main electric current can be derived or shunted to a derived circuit, without expending the remainder in useless work, as would be the case if simple resisting derivations were employed; the object is effected by introducing a counter electromotive device in the main circuit and another counter-electromotive device in the derived circuit, the force or power of these devices being capable of regulation at will. The claims are 2 in number.

17837. "Improved means of generating electricity from heat." P. M. JUSTICE. (A communication from abroad by E. G. Acheson, of America.) Dated December 28. 8d. The invention is based primarily upon the discovery that, if what is known to those skilled in the art as the "magnetic whirl" is produced in or about an electric conductor which is traversed by currents of heat, which tend to escape by radiation or otherwise from the conductor at such points as may be below the temperature of the point at which the heat is introduced, an electric current will be generated in said conductor at each establishment and disestablishment of such "magnetic whirl" cutting said conductor. The claims are 6 in number.

17888. "Improvements in and relating to electro-magnetic marine governors." G. A. SMITH. Dated December 29. 6d. Claims:—1. In the construction of an electro-magnetic governor for marine engines, the employment of an air chamber of suitable construction for the purposes described, in combination with a reversible electro-magnetic arrangement whereby the electrical current generated by a dynamo is caused to be reversed in unison with the movement of a float, substantially as described and set forth. 2. In an electro-magnetic governor, the method of and means adopted for increasing the anticipatory automatic action of said governor by reversing the current acting upon the electro-magnets operating the throttle valve and accelerating the downward movement of the float by means of the elasticity of compressed air in a suitable chamber, substantially as described and set forth.

CORRESPONDENCE.

Jarman's Electric Tramcar.

In the ELECTRICAL REVIEW of May 18th I notice your remarks upon the report of Messrs. F. Walker and Hyde respecting the electric tramcar that bears my name, which I think calls for a few words in reply from me. There was apparently the omission of the capacity of the cells, *i.e.*, 195 ampère hours, the charging current 60 ampères at 76 to 80 volts, the cells being charged in two sets parallel. I have carefully gone into figures many times over as to the actual cost of working this car, and venture to state that as soon as the time arrives to put into everyday practice a couple of these cars (I am pleased to state there is a prospect of this soon taking place), if they are carried out upon the basis I have carefully worked out, I do not fear but that they will yield a profit and a distinct saving over the same number of cars worked by horses. Of course the commercial point of view has not yet been proved from everyday practice, but I cannot refrain from stating here that the report of Messrs. F. Walker and Hyde does most certainly have an indirect bearing, because it shows distinctly the energy employed to do a certain amount of mechanical work.

As to the "engineering point of view," well in this there is little to consider; suffice it to say that the transmission gearing has stood every test that it has been subjected to, and has, further, done its work perfectly from the day it was fitted.

A. J. Jarman.

May 23rd, 1888.

A Plea on Behalf of Anonymity.

No one, Mr. Editor, can for a moment question your absolute prerogative to adopt such measures as you may deem advisable in the interests of your Journal and of your readers and contributors, and undoubtedly your desire is to so manage as to conciliate, if possible, many conflicting opinions.

You now propose to accept anonymous contributions on the understanding that they bear a strictly scientific character, all other letters being admitted to your columns under condition that they are signed by their respective authors.

The step you intend to take with regard to correspondence is, after all, one which perhaps affects your

contributors in a greater degree than it concerns the general polity of your Journal. I, therefore, venture to criticise the course you are about to pursue, since, in the endeavour to discriminate between those contributions which might be admitted under anonymity and those which ought to bear their authors' names, you assume a responsibility which you have hitherto, wisely I think, avoided.

As there appears to be a considerable diversity of opinion on the matter, and as I do not altogether agree with your view of the case, may I beg that you will grant me space for a consideration of the advantages and disadvantages which may be fairly claimed as associated with signature?

The advantages, I apprehend, are :—

To the reader, who is enabled to place a fluctuating value on an article or a criticism in proportion to the estimation in which he holds the author.

To the person whose theories or schemes have been criticised, who, by knowing the name of his critic, is better enabled to formulate his defence or counter attack.

The disadvantages seem to be :—

To consulting engineers, persons in responsible positions, and senior members of manufacturing firms, who may very possibly have just grounds for adversely criticising, from a scientific or general point of view, theories advanced or systems advocated by the very persons with whom they may have business relations.

To junior members of firms, and employés in general, who while writing anonymously are able to freely discuss subjects with which they may have especial acquaintance, but whose appearance in a public controversy might not be acceptable to their employers, as the public might wrongly consider the writers to be authorised agents.

To many persons who, while quite willing to take part in a discussion so long as their identity was concealed, might shrink from publicly exposing themselves to attack, or perhaps to ridicule, and although this age is pre-eminently practical and non-sentimental, such susceptibility is by no means rare.

Now in reviewing the argument *pro* and *con*, it appears to me that in criticism the name of the critic is altogether unnecessary if we deal purely and simply with the subject under discussion, and with the value *per se* of the contribution. If we are to be contented with "so-and-so said this," the whole matter assumes a different phase, the questions in dispute being thus relegated to the decision of, presumably, an expert.

While awaiting this authoritative judgment, is it likely that humbler individuals, who may nevertheless be well acquainted with the subject, will readily expose themselves to receive perchance a public snubbing from a writer whose mere name very frequently commands an esteem quite irrespective of the value of his contribution?

It is thus evident that the correspondence submitted to you for publication must become enfeebled in character and restricted in quantity. Who would run the risk of being dubbed a fool owing to a criticism on some communication from, say, a Sir William Thomson? As an instance, I would call to mind a discussion which was lately carried on in the columns of a scientific contemporary on the subject of the stability of overhead wires, and the employment of springs in connection therewith. There generally arises a period in the lives of most men when they can afford to withstand a public buffeting without sustaining serious damage to their reputations. Do you feel inclined to wait until that period arrives in the lives of your younger contributors?

I do not think that the fact of knowing the name of one's critic can be of any assistance in replying to him, beyond that it presents a means of counter-attack by diverging from the point at issue and introducing a personal element into the discussion. This could scarcely be considered as a desirable method of conducting an argument.

The strongest, and, in fact, only argument which can be brought against anonymous criticism is that it affords a weapon ready to the hands of anyone who desires to traduce an antagonist without affording him the same means of retaliation. But an article of this nature can surely be left to the tender mercies of the editors, since a personal attack is of a very different complexion to a criticism on a theory, a scheme, or a system.

You say, Mr. Editor, that you will only admit in the pages of your journal anonymous correspondence on strictly scientific subjects. Permit me to doubt whether you will be able to draw a hard and fast line where the scientific element ceases and commercial interest commences. Suppose I criticise the dynamos and transformers employed in a particular electric light installation. I may deal with them on an entirely scientific basis, and in showing that their design and construction is faulty I may prove them to be unsuited for electric lighting purposes. The company under whose auspices the installation has been carried out may complain that owing to an anonymous criticism their prospects of contracting for other work have been injured; with equal justice the maker of the dynamos and transformers may urge that his business, with regard to the sale of these appliances, has been seriously damaged. If the company and the manufacturers have suffered loss owing to the statements made in my article, of what benefit can the knowledge be to them that my name is either Smith, Brown, Jones, or Robinson? Should the arguments I have adduced prove incontrovertible, by what percentage would the loss be diminished were a signature attached to them?

To sum up, if in criticisms upon articles which appear in your Journal, or upon matters of general interest, disputable statements are made, or questionable deductions drawn, surely your columns are quite as open to those who consider their theories or projects to have been unjustly treated, as to the authors of the adverse criticisms, and I am firmly convinced that anonymous correspondence is a means of preventing controversies from degenerating into personal squabbles, for it must be remembered that criticisms appearing in your Journal are invariably devoted to the discussion of matter not of individuals. I must apologise for the length of this communication, but the question is of considerable importance to many of your contributors, and one not to be treated with indifference. For the same reason you will pardon the frankness with which I have addressed you.

Incognito.

Tavener's Coulombmeter.

Observing in the current issue of your contemporary the *Electrical Engineer* a notice of an electric meter, said to be of Prof. Elihu Thomson's design, I think that attention should be called to the fact that the principle upon which this meter works has already been adopted by Tavener in his meter, a notice of which appeared in the *Electrician* of December 16th, 1887. The principle involved is that of utilising the heating property of the current for producing an oscillating motion of the containing tube and consequent registration of the quantity of electricity, whether by continuous or alternating currents, passing through the circuit.

As Prof. Thomson's meter has been designed on exactly similar lines as Tavener's, and moreover bears upon it evidence of a knowledge of the prior existence of Tavener's meter, it appears to me that to the last-named is due the credit for the ingenuity manifested in the production of a meter working on a principle so different from those upon which current meters have hitherto been designed and worked. Honour to whom honour is due; to originate a meter working on the principle I have described, which shall register accurately the exact amount of current passing through it at any time is one thing, while to copy such a meter and calmly to appropriate its invention is quite another.

Wm. Phillips Mendham.

May 22nd, 1888.

Electric Traction.

Will you allow me to draw attention to the evident way in which the report of a trial of an electric car was drawn up by Messrs. Walker? You express yourselves strongly as to the valueless character of reports of this sort, but you omit to notice that it contains statements which are untrue. I presume you are unacquainted with the locality. Speaking of the run from Westminster, the report says, the "current at starting on gradient of 1 in 20, 69 ampères." Such a gradient does not exist on the line; the steepest part is at the bridge end, but then they *start downwards*. One would think that the consulting engineers, when they took measurements of the grade and current, had just made observations of an instrument (not Ayrton and Perry's) and tests of a liquid (not electrolyte) whose specific gravity does not reach 1,190, had the time not been past 12.30. We are also quite unable to judge what state the roads were in.

It will be noticed that the mean current from Clapham was 25·5 ampères, 147 volts, 3,748·5 watts; and from Westminster 26·4 ampères, 142 volts, 3,748·8 watts—one of the most truly wonderful performances achieved, as after the short length of run down hill, that one which took 69 ampères, it is almost a continuous rise to Clapham, the only exception being at the Bedford, just before you reach Clapham Station.

The sincere interest I take in the question, feeling sure that electric traction will supersede horses on our lines, prompts me to draw attention to this matter, and thus to trespass upon your valuable space.

William Brand.

May 21st, 1888.

The Brooks Underground System.

We have received the following copy of some further tests on Mr. Brooks's system:—"I have the honour to report the result of the examination of the cable laid by you during 1887 for the Pennsylvania Railroad Company between Broad Street Station and the station at Thirty-Second and Market Streets. The length of the pipe is 7,049 feet, but the calculations are based upon one and one-third miles; diameter of pipe, two inches; inside diameter of cable, $1\frac{1}{4}$ inches; diameter of cable with hemp sheathing, $1\frac{1}{3}$ inches. The cable is saturated and the pipe filled with a mixture of resin and resin oil. The number of conductors in the cable is 53, of which 52 are of the following gauge and insulation:—

Gauge No. 16 American	·05082 in.
Diameter of textile covering No. 8 ...	·12849 „

"The other conductor (mentioned below as No. 1) has

Gauge No. 18 American	·04030 in.
Diameter of textile covering ...	·20431 „

"This conductor occupies the centre of the group, while the others are spliced promiscuously, 18 splices in the total length.

"Fifteen hundred feet of the pipe is in the bed of a ditch covered by running water, the balance is suspended in the braces of the elevated railroad structure in the air.

"The tests referred to below were made on the evening of the 5th of May, 1888, between the hours of 9 and 11, when the temperature of the air was 50° F., so that as the temperature of the water in the ditch is 54° F., the entire length of the line was practically at the same temperature. Twenty-eight of the conductors were in use, 15 for telegraph and 13 for telephone purposes. Twenty-one were connected to earth, and Nos. 1, 2, 3 and 4 were tested for insulation (Nos. 3 and 4 being looped at West Philadelphia).

"Owing to slight disturbances from the working wires, I was obliged to adopt the loss of potential method as laid down by Kemp, 4th Ed., pp. 380 and 381:

$$R = \frac{T}{2{\cdot}303 \times F \times \log \frac{V}{v}}.$$

"The electrostatic capacity of No. 1 was found to be ·167 per mile (although ·17 was used in the computation, and that of Nos. 2, 3 and 4 was found to be ·2233 per mile (although ·22 was used in the computation), as compared with an Elliott Brothers condenser No. 397, $\frac{1}{2}$ microfarad. The number of cells of battery used for these determinations was eight.

"The number of cells used for charging the conductors was 100, and the scale was set so that the reflection from the mirror rested at 350 to the left, in order that the reflected image of the hair line should always remain on the scale. All the tests were made with a 10th shunt.

Immediate discharge of No. 1 ...	260
Discharge after 1 minute insulation	240
Insulation per mile	5,879 megs.
Immediate discharge of No. 2 ...	340
Discharge after 1 minute insulation	300
Insulation *per mile*	2,904 megs.
Immediate discharge of Nos. 3 & 4 together	650
Discharge after 1 minute insulation	530

Nos. 3 & 4.

Insulation per mile	3,523 megs.
Giving an average insulation per mile of	4,102 „

"Yours very respectfully,

"(Signed) OTIS H. KENDALL.

Assist. Prof. of Mathematics, University of Penna.

"*May 5th*, 1888."

[The insulation resistances of the cables, although very good, are not so high as those given owing to errors of calculation; the results per mile are $1\frac{1}{3}$ times too high, owing probably to Prof. Kendall having omitted to notice, when working out his results, that the capacities (·167 and ·2233) are those *per mile*, and not the total capacities of the cables.—EDS. ELEC. REV.]

Curves of Electric Light Supply.

In your paper, No. 546, of the 11th inst., we find a paragraph: "Diagram of Public and Private Lighting in Berlin," by Killingworth Hedges.

As anything published in your valuable paper is not read in England alone but also abroad, would you be kind enough to state that the respective diagram was not drawn up by Mr. Killingworth Hedges, as would appear from the paragraph, but is simply taken from a pamphlet we published some months ago, and of which we presented Mr. Hedges with a copy when he called on us in the spring. We beg to forward a copy under cover.

The diagram *does not*, as Mr. Hedges seems to believe, refer to the *public lighting of Berlin*, but was drawn up by us in reference to electric lighting *in general*, based upon experience gained at various places. It must therefore be accepted as a theoretical diagram, showing an average of various central stations results.

La Lumière Electrique of the 7th April published the paper *in extenso*, giving also the diagram, signed by the author, W. Fritsche.

Fritsche & Pischon.

Kronenstrasse 22, Berlin, W.,
May 16th, 1888.

On a New System of Survey and Construction for Railway Telegraphs.

I commenced to read with interest the article on "A new system of survey and construction for railway telegraphs," by A. E. Gilbert, in your last issue, think-

ing it was something startling, but I have come to the conclusion that he has a very poor opinion of the practicability of our railway telegraph engineers to say that it is usual for them "to trust the important part of the survey of their lines to the inspector or construction foreman, who, as a rule, simply steps the distances between the poles, and judges the height required for each pole by the eye." Whether Mr. Gilbert quotes this from his own personal experience, or from his imagination I do not know, but I think that most of our railway telegraph engineers will repudiate these allegations most strongly.

I have no doubt that Mr. Gilbert's system of survey for railway telegraphs is "new" to most of our engineers, but I consider it a very expensive one, as he has to go over the ground three times where once is sufficient; and again, he requires 14 men where we manage to do ours with five, again he considers two miles over hilly and curving country, or three or four miles over straight country, a good day's work, whereas six miles per day is the average which ought to be done by five men without any mistakes or difficulties.

In the first place a plan of the railway to be laid out is required, with bridges, level and field crossings marked on it, which the engineers department supply.

Starting at the terminal the distance should be measured to the first bridge or level crossing, or to the first place where it is necessary for a pole to stand; this distance should be divided into lengths of 88 yards, or as near as possible to that number, which is the greatest span that should be allowed on a straight line, reducing this span on a curve. A pole should be placed on each side of a bridge or level crossing where much traffic passes over, so as to minimise the danger of wires breaking and falling over them: or if the wires go under the bridge a pole at each side should be placed so that the strain which is caused by the poles on either side being put a greater distance from the rails is greatly reduced. This should be continued until the whole of the distances between each pole are laid out for the length of the line.

These distances are then put on a sheet as in Table 1, and everything is then ready for surveying the line.

pushed along, indicating as it moves the distance it has travelled on a dial, after the manner of a gasmeter, thus, the distance of the lengths of rails corresponds with the distances between the poles; this occupies the attention of one man, who can see by the fingers on the dial when he has gone far enough. The distance from the rails is then measured, the poles being the same distance from the rails all through, thus keeping the poles on the same curve as the rails, except where bridges come over the line, then the distance is gradually dimished to the bridge, and increased as you move away from it, until you get out again to the standard distance, which should not be less than 12 feet. A survey peg, $12'' \times 1\frac{1}{2}'' \times 1\frac{1}{2}''$, is then knocked into the ground at the distance measured; then the surveyor with a quadrant takes the angle of elevation or depression from the level of the rails from which it can be taken every time, and not as Mr. Gilbert suggests; the surveyor and his assistant change places when the ground is higher than the rail level, and in this way six miles per day can be done easily and accurately; the heights of bridges and buildings should be taken while surveying.

This completes the survey of the line, and the rise and fall can be calculated from the tangent taken by the quadrant.

The following is the list of men required for surveying:

Surveyor with quadrant	1
Peg carrier	1
Cyclometer	1
Levelling staff	1
Tape and hammer	1
Total ...	5

The length of pole is then calculated according to the height of buildings, &c., to be crossed, the rise or fall of ground, the number of wires to be carried—the latter should not be less than 14 feet from the ground—and the depth of hole, which should not be less than 4 feet for a 24 feet pole or under, and should increase in depth proportionately with the length of pole. In

TABLE 2.

Remarks.	No. of pole.	Distance apart in yards.	Total distance in yards.	Distance from rails in feet.	Rise of ground from level of rails.	Fall of ground from level of rails.	Plan.	Height of wires from ground.	Height of wires from rails.	Length of pole.	Depth of hole.	Stays or stants.	Guards.
...	6	88	528	10	1·5	...	...	18·5	20	26·8	4·3	1	...
...	5	88	430	12	2·6	...	...	17·4	20	25·7	4·3	1	...
Field crossing	...	...	372	...	...	...	...	...	...	...	...	...	...
...	4	88	352	14	...	...	...	20	20	28·3	4·3	...	...
...	3	88	264	14	...	0·1	...	20·1	20	28·4	4·3	...	...
Cabin ...	...	...	186	18	...	...	...	Height of cabin from ground 10 feet.					
...	2	88	176	14	...	1·1	...	21·1	20	29·4	4·3	...	...
...	1	88	88	14	...	2·	...	22	20	30·3	4·3	...	...
Ter. pole ...	0	88	0	14	...	0·6	...	20·6	20	28·9	4·3	2	...

In Table 1 the distances apart only are inserted, and the other measurements are put in by the surveyor while surveying.

TABLE 1.

No. of observations.	Distance Apart.	Total distance.	Angle of elevation. Of ground from rails.	Angle of depression. Of ground from rails.	Distance from rails in feet.	Stays.	Remarks.
8	88	528	9°	...	10	1	Pole.
7	88	430	12·5°	...	12	1	Pole.
6	...	372	...	...	...	...	Field crossing.
5	88	352	...	0°	14	...	Pole.
4	88	264	...	1°	14	...	Pole.
3	...	186	...	29°	18	...	Platelayer's cabin.
2	88	176	...	4·5°	14	...	Pole.
1	88	88	...	8°	14	...	Pole.
0	0	0	...	2·5°	14	2	Pole.

The distances on the line are measured by means of a cyclometer, with flanges to fit the rails, which is raising wires from the standard level to cross any obstacle, they should rise gradually (about four in every 300 feet). Thus everything is calculated from the level of the rails.

The whole is then put in a survey book containing a plan of the railway on which the telegraph line is to run, with the exact position of the poles marked on it. Table 2 gives the survey book, which is a most complete plan of the engineering details, and gives the foreman all the instructions required, so that there is no necessity for him to accompany the surveying party. Table 2 is a survey for a line of eight wires.

If you compare this way of surveying with Mr. Gilbert's, I have no doubt you will come to the same conclusion that I did, and also that his remarks about the survey of our telegraphs being a neglected subject will fall to the ground, and I may add that ours is a line where breakdowns are of rare occurrence, and not common.

George A. Neale.

N. S. Railway, Stoke-on-Trent.